IMPROVING THE PATIENT'S EMOTIONAL EXPERIENCE OF EMERGENCY DEPARTMENT VISITS

BY

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THESIS

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ABSTRACT

Despite healthcare in the United States being a multi-trillion-dollar industry, the service that patients receive is falling short of expectations. With the passing of the Affordable Care Act, customer satisfaction scores are becoming a larger part of the hospital rankings nationwide and impacting their reimbursement from insurance companies.

With a population of 325 million in the United States, there are a staggering 130 million ED visits each year (CDC and Prevention, 2013). There is no single specific user group for hospitals. Patients are young and old, come from every nationality and range in income and education. It is a place we all want to avoid, but almost every single person has an ED experience in their lifetime. We cannot eliminate health crises from happening, but we can improve the treatment experience.

The Hospital Consumer Assessment of Healthcare Providers and Systems (HCAHPS) is a nationwide required survey that measures the patient perspective of their hospitals experience. Here are four examples of the thirty-two-question survey.

1) During this hospital stay, how often did nurses treat you with courtesy and respect?

3) During this hospital stay, how often did the nurses explain things in a way you could understand?

6) During this hospital stay, how often did doctors listen carefully to you?

20) During this hospital stay, did you get information in writing about what symptoms or health problems to look out for after you left the hospital?

The Emergency Department of a hospital is a facility used to treat unplanned medical conditions. The Emergency Department has to be adaptable to accept the range of patients they treat on a daily basis. Many patients in the United States use the Emergency Department as their primary care because they don't have insurance. Many patients are immediately treated and released but some patients wait for hours because other patients in the hospital require more immediate care.

The primary objective of this thesis centers around improving the experience of patients during their hospital visit in the Emergency Department (ED) by providing information to the patients and staff. The staff, including doctors, administration, maintenance, janitorial and more, would benefit from opening new lines of communication during their visit, and an easy way to plan an organized exit for the patient from the hospital. From the beginning of this research, there was a focus on

three secondary objectives, including reducing patient pain, accurately assigning staff tasks, and staff workload reduction.

This project was centered around human needs. Initial research was guided by the desire to help as many people as possible by studying past and future medical design stories. Interviewing every level of staff at hospitals and the ED patients kept the project concentrated on human needs. Through those interviews and through observations, problems started to emerge about how people interact with each other in inefficient ways. Solutions to many of those questions were tested and tested again to come to a final solution: The ConnectED app.

The ConnectED app is an interface and hardware system that promotes collaboration and communication between patients and hospital staff. Because of emotions like fear and anxiety, patients can be reluctant to share information and ask the right questions. The ConnectED app helps guide patients through the information while reducing fear and anxiety and reduces the unnecessary time doctors and nurses spend with patients.

On the path towards completing this project, the ideas of morality and obligation as designers guided me towards a final solution that tries not to harm while adding the most to the patient experience. By finding and resolving problems in hospitals, we can take what might be the worst day of someone's life and make it a positive experience.

ACKNOWLEDGEMENTS

This thesis project was far from easy, and without the people around me, I would not have been able to complete it: my mom for always being there to listen and support me, my friends for being the escape I needed, and my classmates for always being there to listen and help. Moreover, I want to recognize my late friend who was the catalyst for me becoming a designer.

Even when someone was not helping me with my thesis, he or she still had a profound impact: Ava Bilimoria for keeping me motivated during my thesis year, Gina Taylor for her guidance during my last month of designing my first interface, Professor William Bullock and Director Alan Mette for their guidance and support through everything.

Mostly thank you to my thesis committee: David Weightman for his commitment to helping me learn and create, Joyce Thomas for her support and guidance, and Jenny Amos for her expertise and honesty. Each of them dedicated a lot of their time to help me, and for that, I will always be appreciative.

Dedicated to everyone. Let us try to make the world a better place.

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PREFACE

The PC has improved the world in just about every area you can think of… Access to information and the ability to give a voice [to] people who would never have been heard.

Bill Gates (Hachman, 2011)

CHAPTER 1: INTRODUCTION

Most visits to the Emergency Department (ED) are unplanned and become imprinted memories because of the traumatic nature of the experience. EDs are held in esteem for their ability to handle chaos, yet at the same time joked about because of the way they perform (see figure 1.1). Many problems faced by EDs are due to funding and government policy issues that the hospitals have little control over, but many other problems could be solved.

Figure 1.1 Emergency Department comic by Jim Haynes (Haynes)

Almost everyone has a story about an ED visit they had in their lives and how that experience was negative. Those stories are often not about the pain they were in or the treatment they received, but the experience outside of that, i.e. getting lost in the hallways, filling out the wrong forms, not getting their questions answered, and more. ED patients vary, but one thing they do share is that they are usually first-time users of a hospital. They do not know where to go, what to do, or what to ask, resulting in patients' and staff error often with the consequence of poor care.

Many of those patient stories were collected during this research and directly led to the outcomes of this project. The blue boxes seen throughout this document are those stories.

Patient Story:
"My mother ended up in the Emergency room and needed some tests done. One of her symptoms was dehydration, and so the staff gave her an IV of fluid immediately, but she had to ask four times before being brought a cup of water. She was also freezing the entire visit too. I wish I had been there to help!" - Anonymous interview

Some of the mistakes made by patients are because of a lack of knowledge of the ED system or patients' attention to and failure to follow directions. For example, patients on their cell phones can interfere with equipment or distract and interfere with a doctor's concentration. Some EDs even ban cellphones.

Even simple mistakes can add up to larger costs for the hospital. Staff spending time to get water for patients, walking them to the exit, or using their time listening to a story from a bored patient can add up to increased medical costs. Inefficiencies exist in the ecosystem of the ED where doctors who are making $300k are asked to do things that a volunteer could do, like bringing a cup of water to someone's grandmother.

These mistakes add up to lost time for the staff and can influence the patient experience in a negative way. These thesis investigations have led to the development of an online system named ConnectED (see figure 1.2). The Connected Emergency Department solves innate problems that patients and their families experience when in the Emergency Department. Patients and families are not making these mistakes from ignorance, but out of a lack of education about the hospital's physical, medical and procedural systems. The solution attempts to provide a more efficient and higher quality experience for both patient and staff by sharing information.

Figure 1.2 ConnectED patient (left) and staff (right) home screens. Hansen 2018.

Figure 1.3 Exit & health documents screenshots. Hansen 2018.

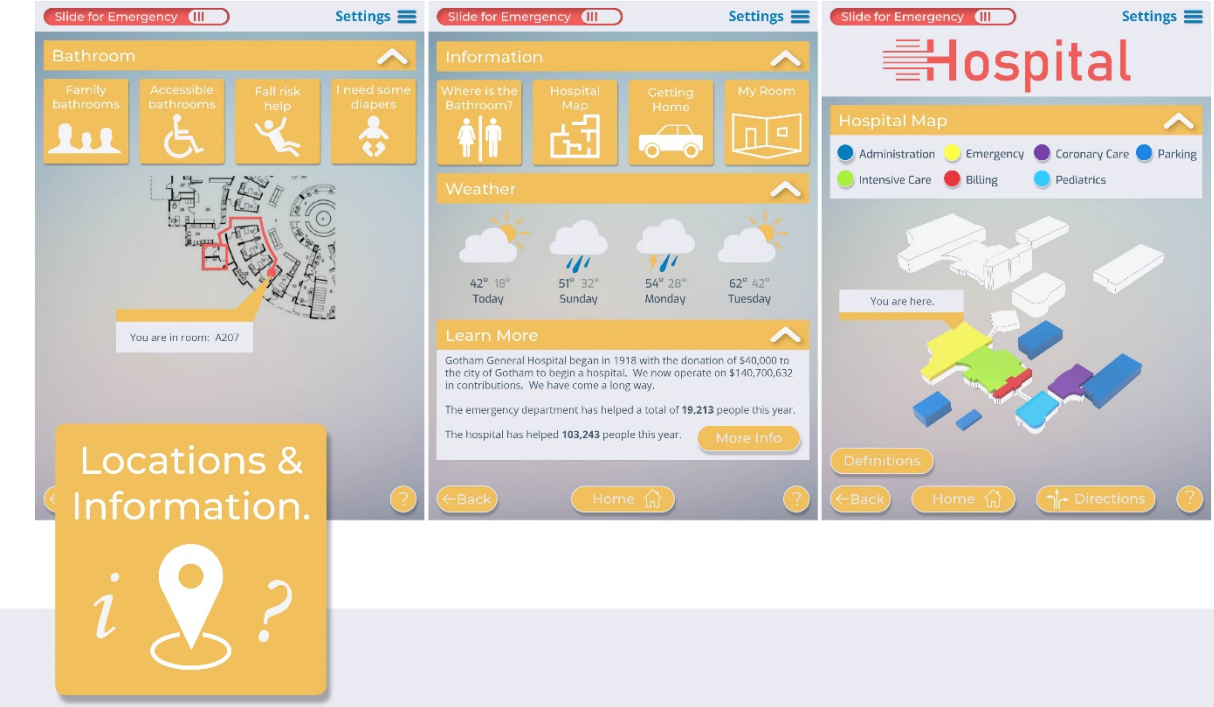


Figure 1.4 Locations & Information screenshots. Hansen 2018.

1.1 THESIS GOALS

The reoccurring theme of all goals was to improve the ED experience as much as possible. Through my review of online resources and academic journals, the thesis goals were narrowed down to help guide the direction of the project. Improving the patient experience was not the highest priority goal at the beginning of the project, but it became so later in the research process. After exploring the patient experience, the priorities shifted as shown in the table below:

Priority	Initial	Final
1 (highest)	Improve the patient's health	Improve the patient's experience
2	Provide benefits to the staff	Increase empathy between people during care process
3	Improve the patient experience	Improve the doctor experience
4	Increase empathy between people during care process	Deliver inexpensive solution that provides income for the hospital
5	Improve the doctor experience	Improve the patient's health
6 (lowest)	Deliver inexpensive solution that provides income for the hospital	Provide benefits to the staff

Table 1.1 Priority list of thesis goals comparing initial to final priorities.

1.2 PROJECT DIRECTION

To improve on the goals in section 1.1, existing problems with those criteria needed to be found. The best way to find problems in a system is to get to the root of the experience. To further the project, an analysis of several areas would need to be explored. The hospital ecosystem, involving administration and laws governing the system, would be examined to determine its influence on the design process. The small human interaction between patients and medical staff during their stay and after would be observed for key insights. Finally, the development process for medical products would need to be studied to learn the unique requirements of the industry.

Entering all those worlds was much more difficult than I anticipated. Hospital shadowing required that I complete extensive paperwork, background checks, immunizations, blood tests, and hours of training. Delays were a learning experience that demonstrated the many steps needed to produce products for hospitals and foreshadowing roadblocks that would define the final solution. These lessons helped guide the process starting with the research.

CHAPTER 2: RESEARCH

The problems in healthcare are not caused by a lack of money; the United States has the highest funded healthcare system in the history of humanity. Design does not influence how much money is designated, but it can help how that money is used. Early in the project area of interest was still unknown. The research and need finding phase of the project set out with one goal in mind: help people.

> *Healthcare in the United States is a mess. Technically, a "mess" is a complex set of problems with inextricable interdependencies. The overall system of healthcare - from services to payment to policy - has grown so complicated that a re-design of its components would not change the system sub-statically. New design thinking is called for, yet where do we start? Designers have no access to the system levers, and most of our work today is aimed at making the components run better and safer. (Jones, 2013)*

This project followed a process of starting broad and then narrowing my focus to smaller segments of the healthcare process. Reading academic journals gave me insights into the past, current, and future trends of healthcare. Visiting multiple hospitals in the state provided me with insights into how different styles and systems can be implemented with the same goals in mind. During hospitals observations of the daily activities, hospital staff showed how the departments work as a single unit and collaborate with other departments. Shadowing ED staff offered insights into the actions that staff must complete as a part of their daily responsibilities.

That research led to several concepts that were then tested with staff through interviews and online surveys. The biggest change in the project came as a result of the patient interviews- the stories that people shared about their experiences in emergency departments and the emotions they felt. With those insights, a final proposal was determined and tested. This chapter reviews the process of starting with the goal of helping people and determining the best way to accomplish that goal.

2.1 EARLY RESEARCH

Because of the delays in getting permission to do onsite observations inside a hospital, early research centered around online and academic resources. Emergency departments are a complex ecosystem, unlike the traditional consumer market for industrial designers. With new legislation and emerging technologies, healthcare in the United States is going through revolutionary transformations. Being aware of those trends in current environments and the future is essential to stay relevant.

Healthcare is becoming part of information technology.

Bill Maris (Popper, 2014)

The types of conditions that bring people into the emergency department are surprising. Unconscious patients entering the ED require substantially different types of designed products than those who, in contrast, are unable to move their arms. Table 2.1, below, lists the most common reasons for ED visits found in Russo's 2006 study. These conditions frequently result in extensive delays waiting for tests to be completed.

Pneumonia	Congestive heart failure	Chest pain	Hardening of the arteries	Heart attack
Chronic obstructive lung disease	Stroke	Irregular heartbeat	Complications of procedures, etc.	Mood disorders
Fluid and electrolyte disorder	Urinary infection	Asthma	Diabetes	Skin infections
Infection of bloodstream	Gallbladder disease	Gastrointestinal bleeding	Hip fracture	Appendicitis

Table 2.1 Most frequent specific conditions admitted to the hospital through the emergency department, 2003 (Russo, 2006)

The number of people that visit the emergency room is shocking. Out of every 100 people, there are 41.9 visits to the emergency department per year (CDC and Prevention, 2013). These high numbers were seen during my observational research; every person interviewed had a story to tell about their emergency room experiences.

While many health care activities can be viewed as closed, or nearly closed systems, EDs are almost completely open systems; its spatial boundaries may be well defined, but its temporal, administrative, and procedural boundaries are vague to nonexistent.

(Wears & Perry, 2012, pp. 711)

Nationally, emergency departments help hundreds of millions of people each year. Designing at that level is extremely challenging, and it is important to observe a variety of environments and see the places where this work is done. After I received approval to enter hospitals for observations[1], it was important to visit a variety of hospitals to view the differences between environments to make some universal design proposals.

2.2 LOCATIONS

Two different hospitals were visited during the research to explore the various environments and to see specific trends. The Shirley Ryan Abilitylab in downtown Chicago, Illinois; and Carle Hospital in Urbana, Illinois.

The Abilitylab was a view into the future of healthcare that at times looked more like a luxury hotel than a rehabilitation institute. Carle Hospital's emergency department looked much like a stereotypical emergency department. One thing that was shared at both locations was a passionate, hardworking staff trying to help people.

[1] Approval for the research came from the Office for the Protection of Research Subjects and Institutional Review Board (IRB) at the University of Illinois at Urbana-Champaign to conduct hospital research and observations. Approval from Carle Foundation Hospital came through the Volunteer Services department's shadowing protocols. Carle hospital required HIPAA training, a background check, hospital prototrochal, blood testing and vaccinations before being allowed in the program.

The Shirley Ryan Abilitylab is a huge building in downtown Chicago in the Northwestern Hospital campus area. This hospital was designed and operated as if it were the future. Tracking devices are used to monitor the locations of all staff and patients throughout the hospital. Those tracking devices give you access to only the parts of the hospital you were allowed.

Almost all the patient rooms are on the south side of the building, with the most light, and the best view. The Abilitylab doesn't feel or look like a hospital. The bright colors, wood accents, open layouts, and minimalist furniture gives the building a feeling like it is on an episode of Star Trek. In other words, it does not feel like a hospital.

Figure 2.1 / 2.2 The Abilitylab – Chicago, Illinois. Hansen 2018.

Carle Foundation Hospital in Urbana, Illinois, is where a majority of the research for this project was completed. It is the only level 1 trauma center in its region. In 2009, Carle treated over 63,300 patients in the emergency department alone.

The physical configuration of the ED has strong contrasts within a single environment. Because emergency departments never close, you cannot remodel the entire ED, so half is very modern, and the other half is dated.

The top image (Figure 2.3) of an intensive care unit room shows a trend similar to Abilitylab's design. Bright windows, wood accent walls, and more warm colors.

The hospital is well maintained, and the staff works hard to maintain the health of the patients. It was very apparent how much they cared.

Figure 2.3 / 2.4 Carle Foundation Hospital – Urbana, Illinois. Hansen 2017.

2.3 IN-PERSON OBSERVATIONS & JOB SHADOWING

To help me better understand how hospitals function, visits were made to multiple departments at Carle Hospital to make observations. Observations of daily activities of staff and patients in extensions of the ED like waiting rooms and nurse stations (the two main hubs of hospital departments) gave insights into the ‘flow’ of the ED. Taking notes of significant moments created a record of highlights and potential problems. Documenting questions that patients asked and their emotional tone, recording equipment usage, sketching the plan and flow of each department created visual and written records used as design constraints and inputs for the development process. This image of my journal notes (see figure 2.5) shows a section documenting every single noise that happened in a one-minute period. It was a lot. Hospitals have pages, alarms, ringing phones, beeping pagers, warnings from monitoring equipment, and many more sound cues.

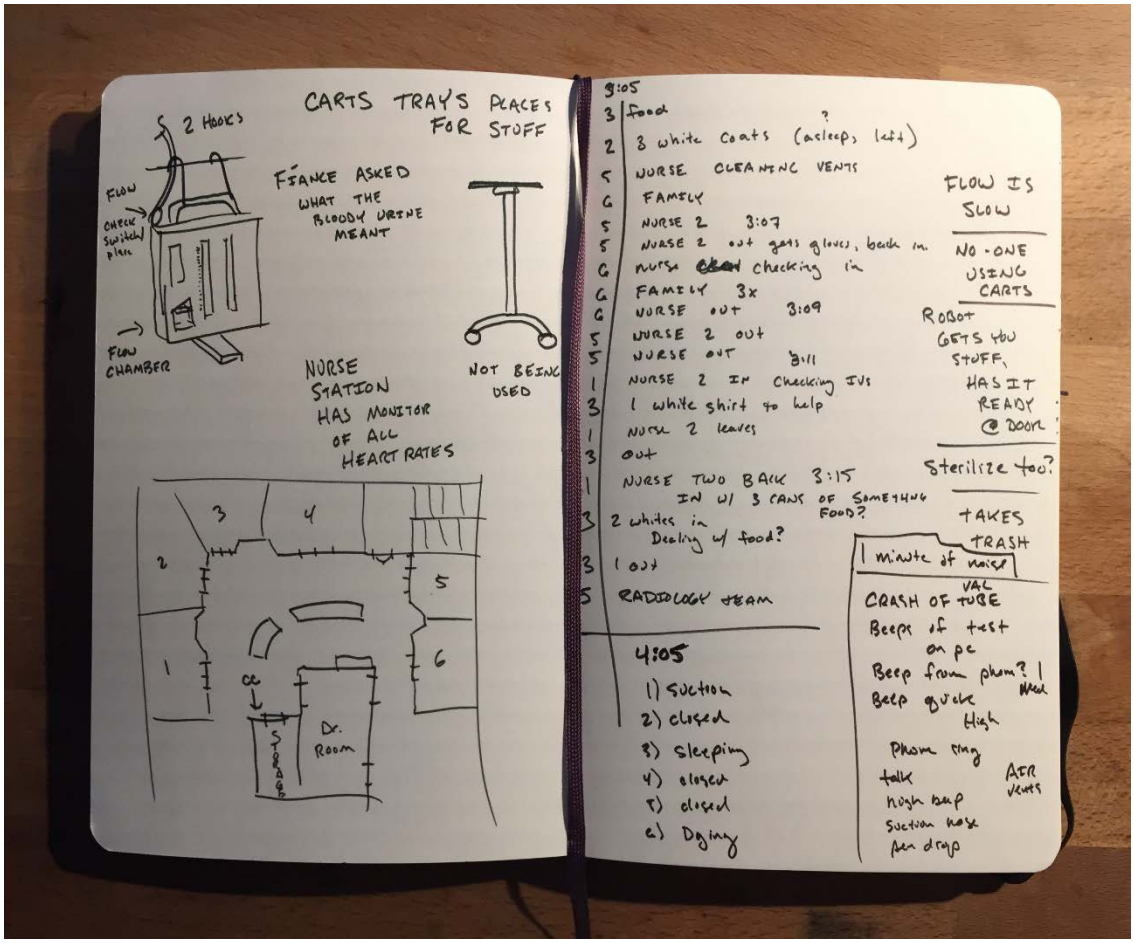


Figure 2.5 Two example pages of notes taken during observations, Hansen 2017.

Because the staff has become conditioned to the environment of the emergency department, only specific noises are noted, and the rest ignored. It is easy for them to be blind to conditions for the patients because that is normal to them. A new patient in the department might find it confusing, scary and disorienting. This difference creates a

disparity in the patient and staff experience within the same environment. Imagine yourself as a patient trying to sleep or rest when you are in a physically stressed condition without concentrating on those noises.

I shadowed within two departments at Carle Hospital, each with a different doctor. Because the names of this research are anonymous, the doctors will be referred to as Doctor Three in the emergency department and Doctor Four in the intensive care unit. Each doctor allowed me to follow them on their regular daily activities of treating patients. There was much contrast between the two departments.

Emergency Department	**Intensive Care Unit**
Classless – staff all wear similar looking scrubs	Hierarchical – doctors wear regular clothing – nurses wear scrubs of different colors
No windows, cramped spaces	Windows and sunlight, open spaces
Unpredictable activities	Scheduled activities
Injuries	Severe conditions
Quick in-and-out	Long-term and slow moving
Spontaneous visits	Family regularly visiting
Dependable products that work	High-tech / state-of-art equipment

Table 2.2 Comparison of the Intensive Care Unit (ICU) and ED

Story: During my shadowing experience, a trauma patient came into the ED. A minute beforehand the staff was standing around joking, and it scared me about their level of preparedness. The second the patient entered the hospital they became silent and attended to everything in an amazing organized pattern. Everyone knew what to do, how to do it, and when to do it as a team. The patient had fallen from a 4th story balcony, and the staff had him in and out of that room and ready for surgery in less than a minute. The coordination was amazing. - Michael Hansen

Despite those differences, I saw a few things that were true of both departments. Both were dynamic and despite all the apparent chaos, things were well run. They all had centralized hubs where nurses worked which were the heart of the departments. All doctors had private spaces where they could remove themselves from distraction. I observed that Doctors Three and Four always made sure to check the patient's name before talking to them. This was just one of many small gestures the staff did to make patients feel welcome in the hospital. The comment most shared by Doctors was the how much they cared.

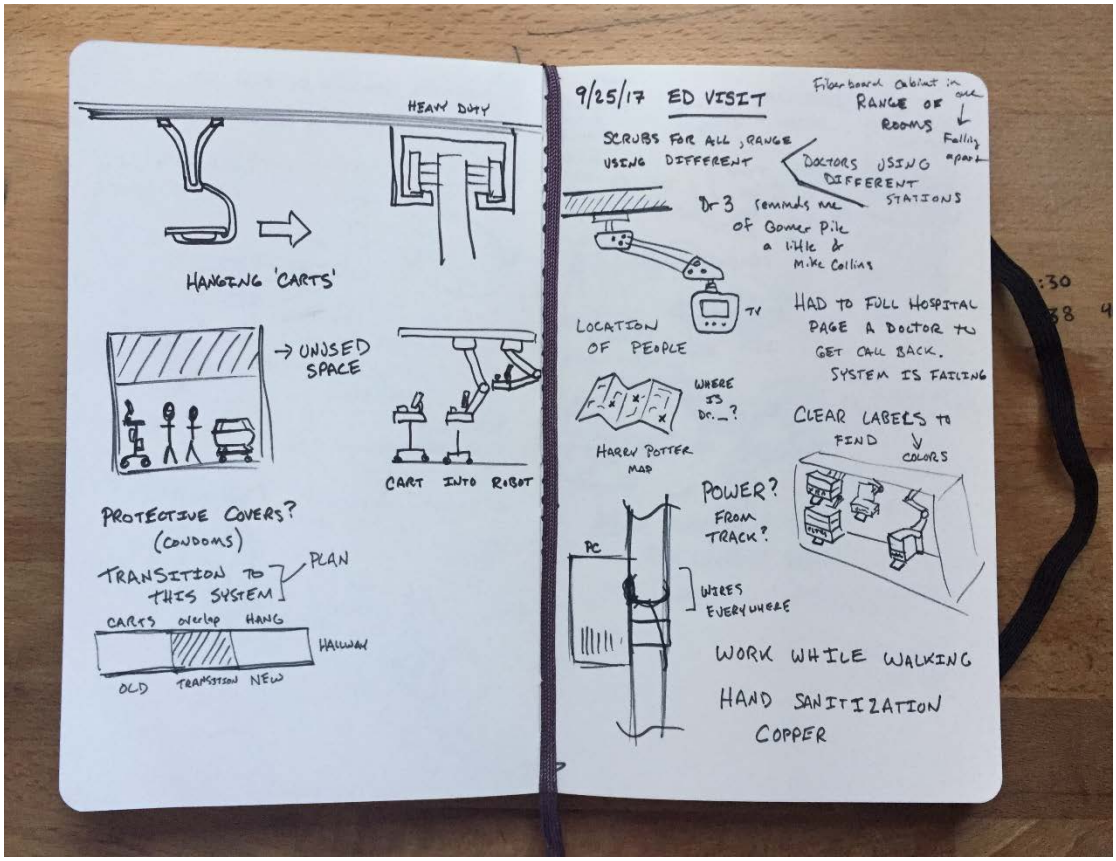


Figure 2.6 Two example pages of notes taken during observations. Hansen 2017.

During the process of shadowing, notes were taken on both small and large problems without judgment about their potential for solutions. Below is a list of many of those problems, some of which are addressed by the final solution.

Problems observed:

-Otoscopes are hard to keep track of.

-Hospital beds are challenging to navigate down halls; staff will push a patient bed with one hand and an IV pole with the other down a crowded hallway.

-The hallway outside the patient room is a spot often used by staff to meet; this location is not designed well for privacy or space.

-Doctors are a limited resource and should only be used for high-level work but were sometimes used for low-level work. Resource management needs improvement.

-Lack of hierarchy in the emergency department can be confusing.

-Even when a single IV system is in use for a patient, the tubes and wires become complicated and disorganized.

-Adding equipment usually brings increased cords to manage. The carts can be difficult to plug in and unplug as well. The extra cords and the carts themselves can become tripping hazards.

-Doctors' workstations are potentially an under-utilized space opportunity. 90% of the doctor's attention goes towards only 5% of the space (the computer monitor).
-The communication process between staff in different departments or hospitals using telephone is very inefficient. Phone numbers are often manually typed in to make calls from handwritten notes/lists or memorized from voicemails. Leaving messages to call back can be an overly complicated process.
-Doctors and nurses have access to computers all over the hospital, but some of them have permanent chairs that aren't adjustable, desks that can only be used sitting, and are not setup for proper ergonomics uncomfortable to use or are limited in number. Nurse station computers are available but are only used regularly during stand-up meetings.
-Staff would rather walk to another room where they have left their computer login open rather than type in their passwords on a new computer. It discourages the use of computers and slows down the patient treatment.
-Portable computer workstations in the hospital rarely used. These carts are too difficult to move around, and the wireless is not as fast as hardwired computers. Laptops are carried around more often but need a flat surface to be set on before use.
-Medical computer stations are usually designed with the intention of only one person using it and are not family friendly; a group would have to crowd around a small monitor to view imaging, requiring medical staff to sometimes repeat information and for family taking turns.

2.4 STAFF FEEDBACK SURVEY

Observations and criteria developed during the shadowing and research process were advanced into potential solutions through brainstorming and sketching. Hundreds of ideas were created by following the criteria from section 1.1. Those ideas were narrowed down to five possible concepts for further research, with the goal of putting them in front of medical personnel for feedback. The concepts explored include: 1 Soft wearable health sensor, 2 Patient communication, 3 Robotic Guides, 4 Robot delivery / storage, and 5 Robot arm assistants.

The five concepts (see figure 2.7 thru 2.11) and survey questions were shared through Surveymonkey.com and sent via email to 5 doctor and medical staff participants who forwarded the survey on to colleagues. Each concept was shown individually with a short description. Participants were asked to score how likely they thought patients and medical staff would be to accept that concept on a scale of 1 (least likely) to 5 (very likely). Additionally, participants were requested to provide comments for each concept. Only nine responses were received. However, the comments made by these participants helped focus/direct the rest of the project much more so than the actual scoring.

Patient Story: "I remember just having to wait a lot. I never knew when the doctor would come, and then it seemed she was gone in an instant. The nurses came in much more often, but they always seemed in such a rush. When it got too late, my friends had to leave me there alone, and that sucked, and the staff left the door wide open so that I could see people outside, but it felt like they were watching me, and I felt lonely despite people being all around me."
– Anonymous Patient

Figure 2.7 Concept 1. Hansen 2017.

2.4.1 Concept #1 Soft wearable health sensor – survey response score 3

Problem: Sometimes while a patient is in waiting room, their condition can become severe without the staff being aware. Medical equipment is not used in the waiting room to monitor patients.

Concept: New advancements in manufacturing technology are allowing smaller and flexible electronics that are more comfortable than current products in the market. A device would be worn around the arm to monitor blood pressure, heart rate, oxygen levels, etc. Even the sweat on the body could be used to measure specific chemicals in the body.

Pros: Monitoring more patients than before / New way to communicate with patients / More patient data.

Cons: Sanitization is difficult with fabric / Frequent theft / Hard to make a one-size-fits-all product resulting in higher costs / Skin-to-skin requirement difficult to maintain.

Hospital Staff comments: “[Patients] waiting in triage that may need additional monitoring but don’t need to go back to emergency.” / “I would be worried these would be stolen by ED patients.”

Figure 2.8 Concept 2. Hansen 2017.

2.4.2 Concept #2 Patient communication – survey response score 3

Problem: Communication between staff and patients has its challenges. Sometimes doctors walk across their entire department to ask one simple question from the patient which causes medical staff to expend time traveling around the hospital instead of helping patients.

Concept: Wireless technology and tablets can create an ecosystem within the emergency department for communication. This would also introduce the capability to communicate with family or others outside of the hospital. A device would allow for the patients and staff to have much greater access to each other.

Pros: Low long-term cost / Better experience for patient / More efficiency in time use for staff / Distraction for patients from pain

Cons: Potential theft issue / Sanitization difficulty / Device would get in the way / Some patients would be incapable of using the device

Hospital Staff comments: “In place of a call light, [patients] could ask the nurse what they need. It would save steps and time.” / “There would be an infection control issue.”

Figure 2.9 Concept 3. Hansen 2017

2.4.3 Concept #3 Robotic Guides – survey response score 1

Problem: Navigating around hospitals is a challenge for some people. Hospitals are usually large, renovated buildings, with multiple floors and departments. Staff and volunteers are around to help, but not always. The staff also spend unnecessary time answering those types of questions.

Concept: Bringing a domestic robot into the hospital environment could be a guide for patients and visitors, helping them move around the hospital, saving time for the medical staff.

This device would roll around the hospital with a tablet interface to answer questions for people. The device could also be used as a telemedicine portal for other doctors in the hospital or around the world to 'roll' into a room to talk to a patient from a distance.

Pros: Novel for patients / Long term low costs (reduced staff)

Cons: Will get in the way / High initial cost / Volunteers can do it for free / Contamination issue / How does it learn? / Limited need for it / Removes human touch from the communication

Hospital staff comments: "Seems too strange to be accepted. Human faces/volunteers do this job now." / "When you are sick, you want a personal connection."

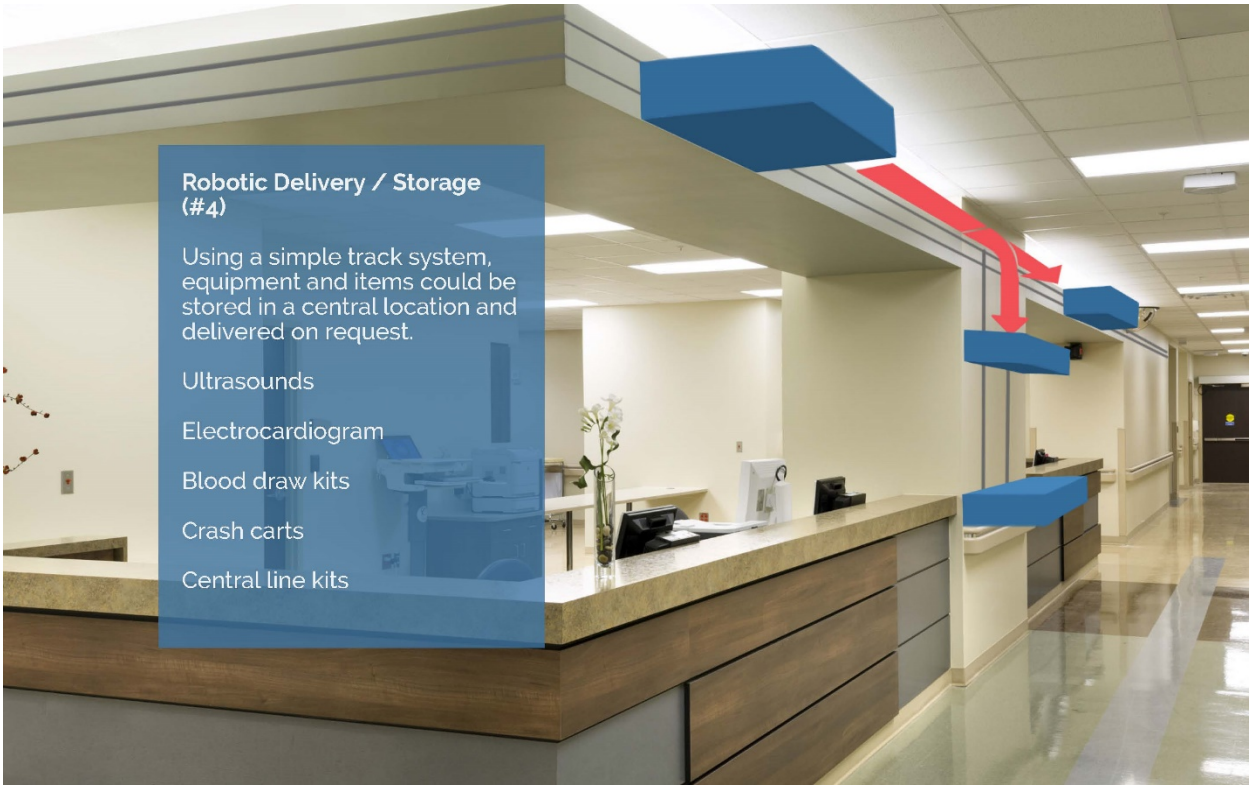


Figure 2.10 Concept 4. Hansen 2017

2.4.4 Concept #4 Robot delivery / storage – survey response score 3

Problem: Seeing patients parked in the hallway because there aren't enough rooms for everything creates a negative experience for the patient. Large numbers of patients, small budgets, and equipment storage limit the number of private rooms in an ED for patients and staff. One of the reasons for this is the need for storage and readily available access to products and equipment for the staff. Getting items around the hospital can be a challenge and expensive task. Low-level volunteers might not know how to transport a material the correct way and paying medical staff to move something across the hospital is a waste of resources.

Concept: Automated transportation and storage devices could save time and space for the staff, creating better services for the patients.

Pros: Takes advantage of the unused wall and ceiling space / Items easier to find / Equipment storage

Cons: Makes storage better, but access worse / Only useful for commonly used non-critical items / Already have vacuum tube system / Potential safety hazard

Hospital Staff Comments: "In the ED, all the equipment mentioned is at our fingertips already."

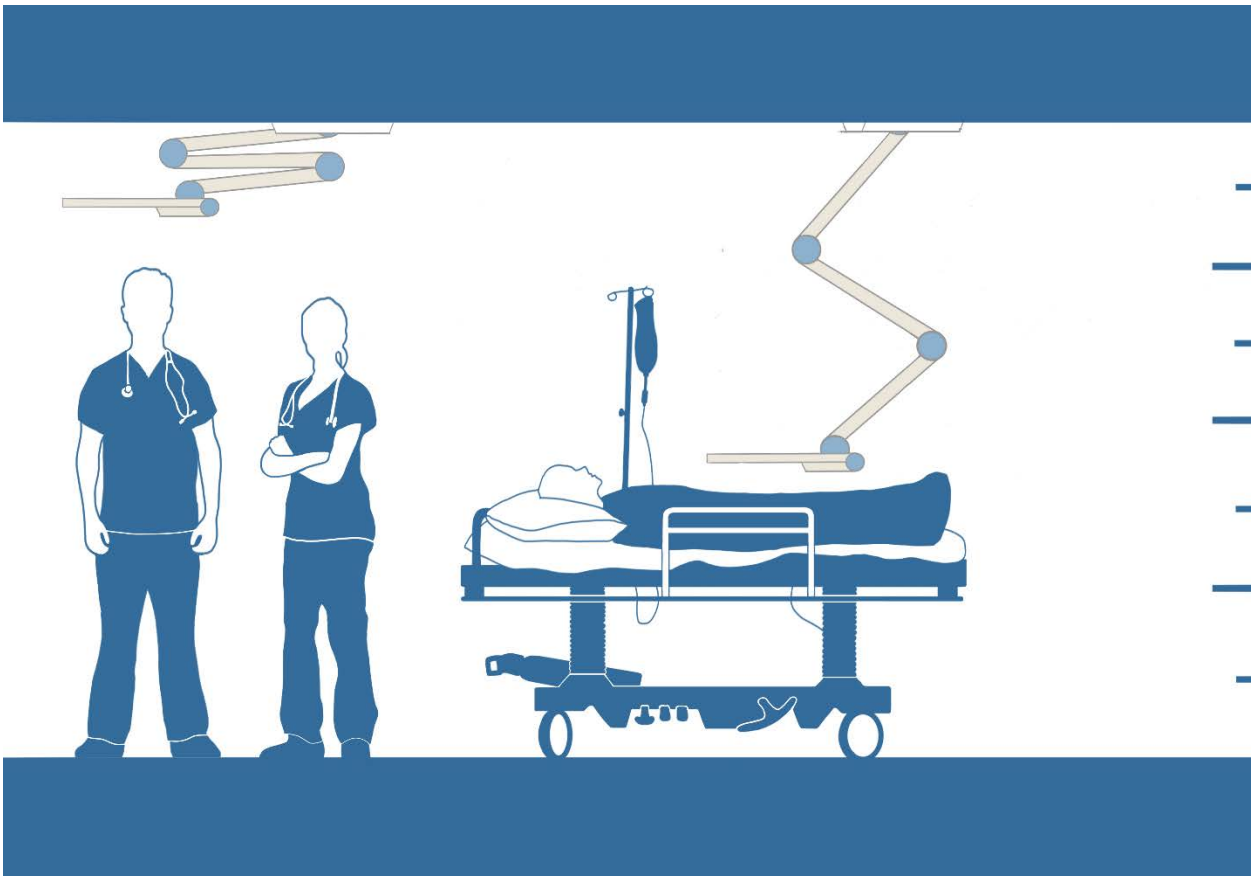


Figure 2.11 Concept 5. Hansen 2017

2.4.5 Concept #5 Robot arm assistant – survey response score 2

Problem: Because of restrictions in the amount of space the hospital has, patients' rooms can be small and lack amenities such as bedside tables, televisions, and even privacy. To help compensate for the lack of space and amenities, hospitals are starting to utilize ceiling space more. Being able to get items quickly out of the way is important during many procedures in the emergency department.

Concept: An arm mounted from the ceiling space could create an extra 'hand' for the medical staff and deliver additional functions, such as holding a light, administering chest compressions, or holding a syringe. This concept was not developed well enough for the survey and participants were often confused by the illustration and description.

Pros: Improves staff efficiency / Takes advantage of unused space

Cons: Trying to do too much / Potential dangers / Unproven technology

Hospital staff comments: "This seems to have some promise if developed further."

Concepts #3 - robotic guide and #5 - robotic arm, were the most poorly received by the survey participants. As the professionals interviewed weren't interested in having that technology be a part of their work lives yet, these concepts were abandoned. Concept #2 – Patient Communication Device had the most positive numerical and comment response. The negative criticisms were all easily solvable problems.

Ultimately, this survey helped narrow down the direction of the project to one function: helping the patient communicate. The next step in research was to find out how that device would be used to help the most.

2.5 INDUSTRY DATA AND STATISTICS

The goal of real healthcare reform must be high-quality, universal coverage in a cost-effective way. – Bernie Sanders (Sanders, 2014)

Healthcare in the United States is privatized and not universal. According to Gallop data 12.2% or about 39 million Americans are uninsured (Auter, 2018). Without insurance, many of these Americans' only resource for healthcare is the emergency departments of hospitals. This leads to less preventative medicine being practiced and more people crowding in the emergency departments. This can mean long waits to see doctors and specialists, higher costs for hospitals, and higher priced visits for the uninsured.

With a population of 325 million, the United States has about 130 million ED visits each year. Of those 130 million, less than 10% end up admitted to the hospital, and 1.5 million are admitted to critical care units (CDC and Prevention, 2013). This means a majority (~90%) of visits are for non-critical reasons.

Once a patient gets to the hospital, long waits are common. Only 29.8% of patients are seen in fewer than 15 minutes (CDC and Prevention, 2013), and 88% of ED patients wait on average 29 minutes to be admitted and 146 minutes to be treated (Treatment Times CDC, 2011). Long wait times in the ED are commonplace and stories of waiting 5+ hours are not unheard of. The experience of visiting an ED is already traumatic and adding on hours of waiting might be a problem that design can help with.

"One of the most important goals of any healthcare system should be patient satisfaction." (Alijani, 2015, pp.13)

2.6 PATIENT INTERVIEWS

After considering how much energy the healthcare industry workers put into helping people, it is important to ask the recipients how their experiences compare. To learn the perspective of the patients' interaction, surveys were created, and one-on-one conversations were documented. I posted a SurveyMonkey survey on the social media site Facebook to request anonymous ED stories. The survey simply asked to tell me

your story of visiting the Emergency Department. Make sure to include the emotions you felt during the experience." The online survey resulted in nine responses of stories and experiences. Maybe because of the fear of telling their story online, many people requested to tell their stories in person and an additional 15 stories were collected. Sharing information about this thesis with friends, family, students, classmates, and acquaintances resulted more stories than the social media post. It was determined that the staff's care was more focused on the health of the patients than the patient's experience at the hospital, which it should be, but that does not mean the experience is not important.

Patient Story: Ending up in the ED in the middle of the night, one person talked about how slow time seemed to be moving while there. It was boring. They had to use the bathroom, but because they were alone in the room they did not want to leave and miss the doctor, so they held it in. It was so uncomfortable, and I did not know what to do. -Anonymous patient # 12

The online survey had one request and one question listed in bold below, followed by anonymous responses to them to help inform the decisions during this design project. All are direct quotes from the participant answers. 8 of the 9 responses to the surveys reported negative emotions and responses. 14 of the 15 in person interviews also had negative emotions. Below are selected responses to those questions that relate to the project.

1) **Tell me a story about when you were in a hospital as a patient, employee, or visitor that stands out to you. If nothing stands out, just your most recent experience is good. Please include any emotions/feelings you experience.**

"One of the most challenging things about all of the appointments that we go to is the timeliness or lack thereof of all of her appointments. It is often very challenging to get a hold of doctors and especially to have them connects directly to our insurance, which is necessary sometimes."

"I was very cold and felt very bored and alone. So cold my body was literally shaking and jaw chattering. It took several hours. I didn't know when the doc was coming back in or how much fluid he was giving me or how long I'd be. Huge lack of communication."

One person described the experience as full of "fear and uncertainty as well as distrust."

"Delivering my baby and scared out of my mind."

2) **How would you change that experience?**

"Get all information I needed before visiting"

"simplify the process of checking in"

“make an appointment online”
“There needs to be a structure" to allow for better timeliness and better communication.”
“Opening a better line of communication between ER staff and the patient.”

Patient Story: After having a massive pain in her stomach and ending up in the emergency room, one person used the last 1% of her cell phone battery to text a friend asking him to bring a charger for her. What if that friend was not available or out of town? Communication plays a vital role in our daily lives, let alone during an emergency. -Anonymous patient #28

2.7 PROBLEM STATEMENT

Problem Statement: Despite the best efforts of the hospital staff, patients in the emergency department feel unconnected. Feelings of anxiety, nervousness, panic, and fear are still common.

Cellphones gave us the ability to communicate with almost anyone in the world, but also reduce the number of face-to-face interactions we have with people. Some would argue reward is not worth the cost, so we must ask ourselves “what role do technologies play in morality?” (Verbeek, 2014). Increasing communication between people, especially in a medical, ED situation is an important problem to try to solve.

How can I use technology through interactive devices (i.e., computer, tablet, cellphone, etc.) in the locations that patients spend the most time (i.e., waiting room, patient room, etc.) to increase and improve the communication between patients and medical staff?

If you look at healthcare today, it’s all about disease. It’s not about understanding wellness at all. – Leroy Hall (Hall, 2014)

Patient Story: I remember hearing a page while shadowing “Doctor Three to hallway nine” and didn’t think that could mean what it sounded like. It did. We walked up to a girl who was maybe sixteen, sitting on a bed in a hallway and completely flustered by what was going on around her. Imagine being asked private health information in a crowded hallway with strangers around you. Sometimes in the emergency department, they have something called hallway medicine. – Michael Hansen

CHAPTER 3: TESTING THE IDEA

Testing a concept is about validating your ideas. Prototyping an idea and running it through multiple rounds of testing and redesign lead to a better product. No one person can create a great product; it takes a team. To further resolve the problem statement a variety of components would need to be tested to solve the unknown problems that exist. This section will cover those components and methods of testing.

"The design process is about designing and prototyping and making. When you separate those, I think the final result suffers."

- Jonathan Ive (Prigg, 2012)

Prototyping is not limited to the physical world. Getting user feedback through surveys, interviews, conversations, and interactive review sessions are all ways to test an idea inexpensively before investing time and resources into creating the product. Sometimes the goal of a specific methodology is to test an idea which results in solving a problem you were not previously aware of, and that is one of the beautiful parts of the design process. Each test was run with a specific problem in mind. A method for gaining insight or solving that problem was set out, and the results were documented and influenced the final design.

"Design should be more than the product of a good idea or fixing existing issues. It should be the result of a process that opens up a multitude of possibilities through a vigorous design process."

(Green, 2015, pp. 11)

3.1 STAKEHOLDER INTERVIEWS

Problem: The healthcare system has unique requirements for design development that other industries do not require. In a traditional consumer market, the purchaser is often the user. In hospitals, the purchaser is always many steps removed from the user (doctor, nurse, etc.). Each role needs to be understood, and the unique inputs of each of those positions were unknown.

Method: A series of interviews were held in person and over the phone with individuals who are providers and/or users throughout the healthcare industry. A total of 22 interviews were conducted over a period of 60 days. The questions revolved around understanding their role and their position's unique requirements for developing and purchasing medical products. The interviews addressed three main points:

1) Criteria for the design process and product introduction
    a. What inputs or limitations do they have for the design process?
    b. Where should design inputs come from during that process?
2) Priorities for stakeholders

a. What is important to the stakeholder in their daily workday?
b. What are your goals of the stakeholders work in healthcare?

3) Needs of the stakeholder
    a. What are the core needs of the stakeholders?
    b. What are the needs of the stakeholder?

Results: The health care role of the individuals interviewed are listed in bold, followed by insights (paraphrased quotes) from my conversations with them. This is all followed by a broader view of the overall ecosystem of stakeholders in the healthcare industry.

Medical Product Designer: Sanitization and materials are critical. Timeline from a design to the use in a hospital can take five years or more.
Emergency Department Doctor: Wear good shoes. You never know what to expect. We love tech when it works. Voice-to-text works well enough.
Emergency Department Nurse: Document everything.
Emergency Department Nurse Supervisor: Billable items are stored and tracked well.
Intensive Care Unit Doctor: Knowing a patient's name can make a huge difference. We have the equipment we need; we need to find it and store it better.
Intensive Care Unit Nurse: Patient transportation is a struggle. If we can improve the patient's experience in any way, we will.
Clinic Coordinator: Patients sometimes needs help to make the right decisions. EMR systems are already there, but customization is critical.
Government Legislator: The laws are there to protect people, they may not be perfect, but still help.
Emergency Department Patient: I wish I knew what was going on. The staff always seemed like they were in a rush.
Patient families: I wish I could do more.

The initial part of this project concentrated on the small ecosystem of doctors, nurses and staff only. Through the stakeholder interviews, it was determined that many more roles should be involved in the development and use of medical products. The government and administration are deeply involved in the purchase of the products as choosers. As users, doctors are involved in that process, but usually only making recommendations in product development and for product purchase. The doctors and nurses are the users of the products and the patients/family are consumers of the products and services. Government, administration, doctors, nurses, staff, family and patients should all be considered in the design and development process.

Because of how much time they spend with the patients, the nurses have a higher level of communication with the patients and family. The doctors spend less time directly with the patients but spend considerable time with the nurses planning the

patient's care. The nurse's connection with the patient is stronger than that of the doctor's connection with the patients. The nurses are at the center of communication within the departments, having strong connections with both the doctors and the patients.

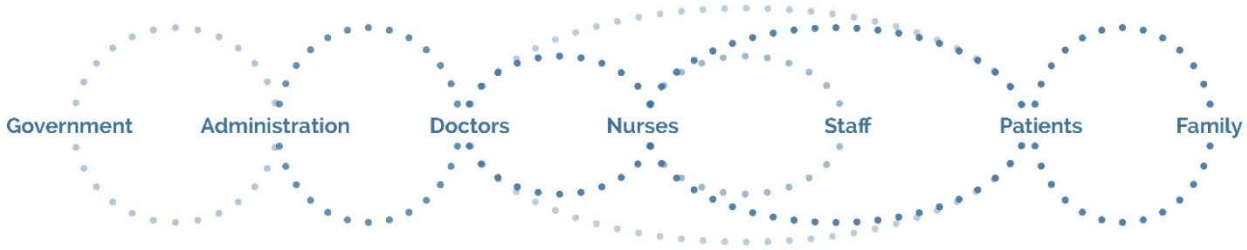


Figure 3.1 Visualization of the strength of the connection between hospital stakeholders. Hansen 2018.

Upon analysis of the different roles in healthcare, it was discovered just how complex the system was. Everyone single person is trying to help, but administration focus on money, doctors focus on treating patients, staff focus on safety, and patients focus on getting better. Different perspectives all wanting the same thing but in different ways.

3.2 PHYSICAL PROTOTYPING

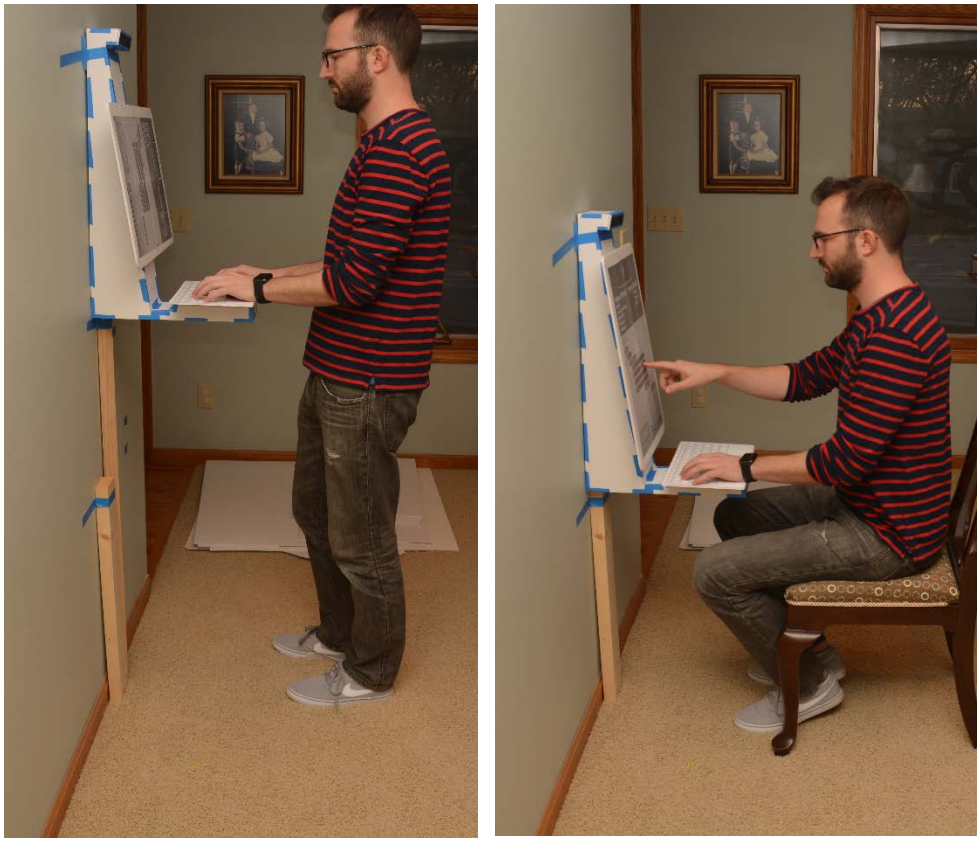
Problem: When interacting with a digital interface, the physical form of that interaction can influence the functions of the application. Stakeholder interviews brought up issues like theft, and patients impairment or, and physical disabilities having an impact on the use. Because the patients in EDs come from every end of the spectrum, the design needs to be as universal as possible. The location, size, and interaction with the device are all influenced by those problems.

Method: After considering the physical problems, three tests were run to determine what solution would fit the environment. Each of the tests had goals of understanding accessibility, from location accessibility, to visual accessibility, and staff interaction. Foam-core prototypes were constructed to test for unforeseen issues, ability to promote collaboration, and usability. I acted as both patient and doctor to test the interaction with the devices.

The models were constructed from foam core to keep the weight low and to keep the prototyping process from being cost prohibitive. Although foam core can be a weak material compared to the metal and plastic the final model would be constructed from, reinforcement pieces were used to increase the rigidity of the prototypes to be close to that of the final product. Because the goal of the prototypes was to primarily test for usability issues, the use of foam core was suitable for the needs of the testing.

I made 5,127 prototypes of my vacuum before I got it right. There were 5,126 failures. But I learned from each one. That's how I came up with a solution. So, I don't mind failure. – James Dyson (Salter, 2012)

Test One: The initial device was designed to be a wall unit, with an adjustable height system. The wall attachment would prevent theft, and the keyboard and height adjustment would be more accessible. I determined that the unit was restrictive to patients because they would have to get out of the patient bed to use the device. Using the device at different heights caused additional issues like the keyboard sticking out from the wall, which was a safety risk. The device's location was also restrictive to many patients and therefore not up for further consideration.



Figures 3.2 & 3.3 Wall interface test model. Hansen 2018.

Test Two: The visual accessibility was controlled with two modifications, screen size, and location. Foam core sheets were cut out to varying sizes, ranging from 10" x 7" to 24" x18" to determine if a larger size would benefit the user. Because the screen would be used in a variety of positions (see figures 3.2 & 3.3) the device would need to be moved around, and therefore could be moved closer to the user. The design decision was made that the large size screen was not necessary for its use and using a smaller screen would save on weight and cost, which is the main priority of the administration.


Figures 3.4 & 3.5 Physical location of the screen. Hansen 2018.

Test Three: Combining the first and second test prototypes, the final test was done to create a system that could be used everywhere in a room at different orientations for the patient and staff. It was concluded that the size was too large and that the support arm would have to be more structurally strong because the device was shaking while the users were typing on it. It was determined with these tests that a keyboard would be ideal, but not a necessary feature of the device.

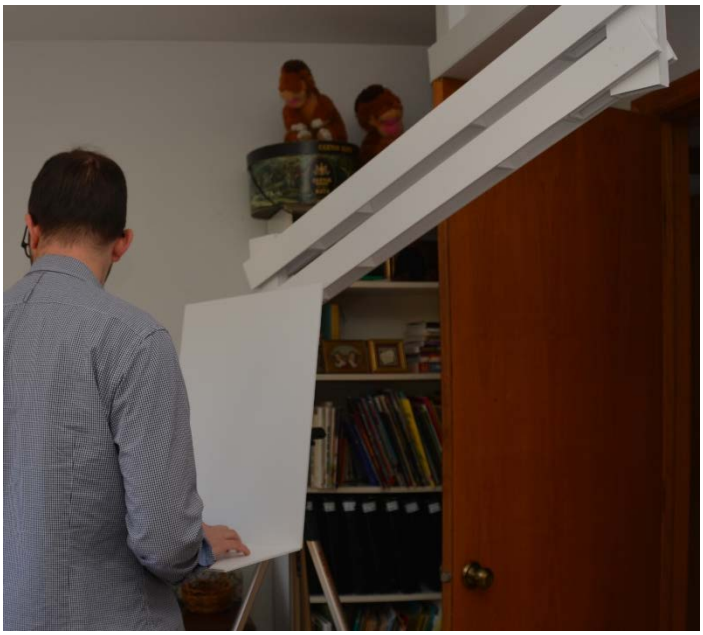


Figure 3.6 Ceiling mounted universal location mount. Hansen 2018.

Result: The results concluded that a device mounted to the ceiling would benefit the user and staff while solving the problems stated by the stakeholders. Allowing the most amount of user's access to the device while not getting in the way. A patient unable to move from their bed would still have access. The device would be theft resistant because of the mount.

The final test model is the direction of choice for future physical product development. The display is anticipated to be the size of a traditional iPad (6.6" x 9.4"). Areas like sanitization and cleaning would need to be explored and the control/handles to move the device around the room would be the next essential tests to be run to develop the project to its final stage.

However, at this point in prototyping, I recognized that the digital interface for this design was even more critically important to patient and medical staff usability, and so my focus for the remainder of this project was to develop that interface.

3.3 PAPER INTERFACE

The digital interface was initially being developed concurrently with the physical design of the product. Like some prototypes start out simple and low-fidelity, so did the digital interface of the app. When the focus of the design shifted solely to the digital interface, this development process took on a higher urgency and required quick ways to visualize screens and make changes.

Problem: The way in which patients and medical staff would access information is important. One of the goals of the app was to have an easily accessible interface that could be learned and used quickly. Most patients in the ED are new patients and would, therefore, be new users of the system. Not being able to find a feature would be the equivalent of them not knowing it exists. Patients need easy access to the important information that can help improve the experience of visiting the hospital. Medical staff will become expert users of the system using it on a regular basis, creating a dramatic difference in interface between the patients and staff.

Method: Representative screens were designed in Photoshop and InDesign and printed on quarter sheets of printer paper to layout and manipulate. The sheets were marked up with changes or new features, stacked, and moved around to group sections of similar groups together. Prototyping the process of using the app was as simple as touching the button on the paper sheets and moving to the connected screen to start testing the flow. Individual sheets were moved around and taped together to create a flow of information. Many changes and features were added during this process.
Result: This process started leading to groups of information that helped guide the design process. For example, the information on finding the bathroom was combined with the map of different departments in the hospital as "locations."

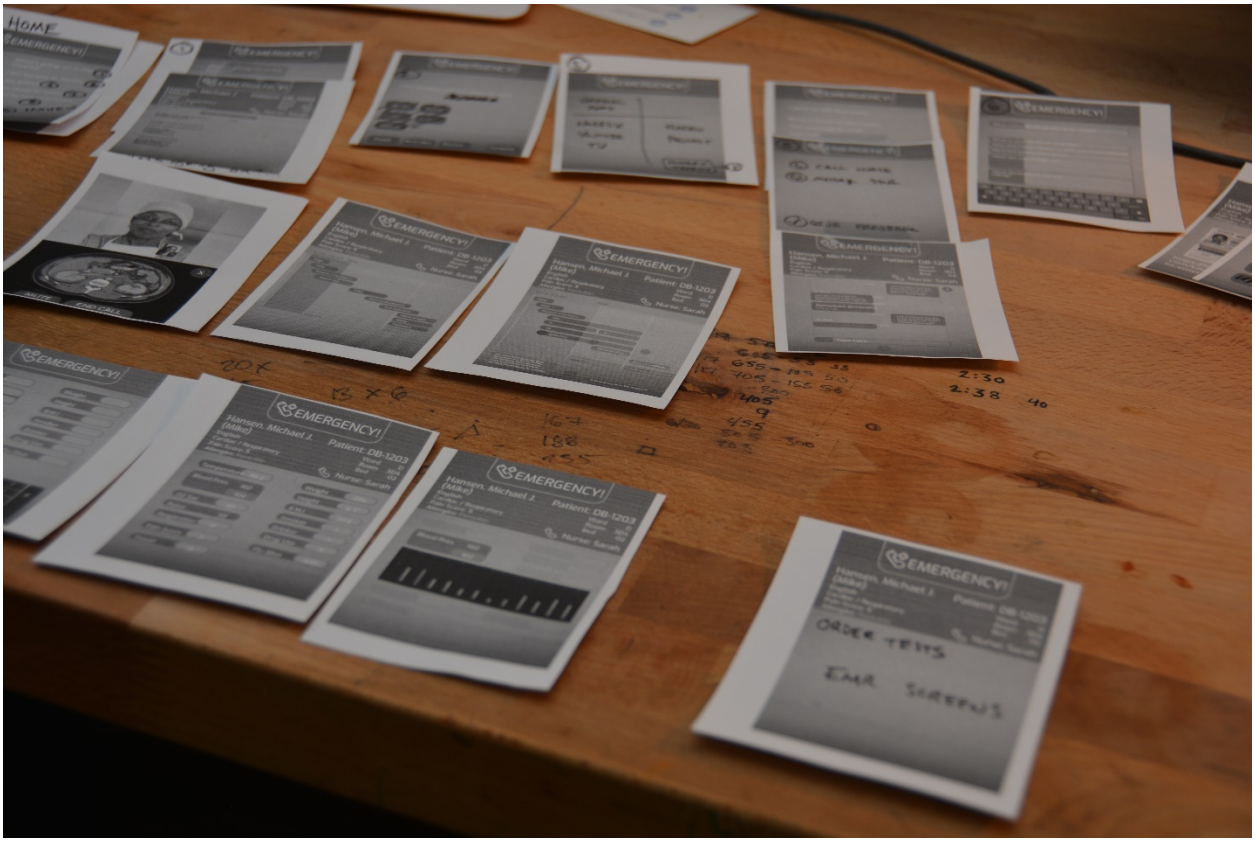


Figure 3.7 Paper low fidelity prototype. Hansen 2018.

As the needs of the app grew, so did the complexity of the prototype. The desk on which the prototype was being created became too small for the complexity of the information in the application and the paper prototype was transitioned to the wall. This complexity came from the need to interface the staff information into the patient experience, as well as providing a third version for visitors that protected private medical information than the other two sections. The need to have patients and staff connected required interactive sections to accomplish similar goals but in different interfaces.

M. Story (2007) wrote about principles and guidelines for medical product universal design. The criteria that Story applied to UIUX projects was filtered to give guidelines to the needs of the design process of the ConnectED app. Below are four examples of those guidelines and how the applications changed to accommodate those needs.

Facilitate the user's accuracy and precision – Because many patients in the emergency department can be impaired or have limited mobility larger icons were used to make the app less accident prone. The digital emergency slide at the top of the display was originally a button, but that could easily be pushed, so a slide was added to reduce accidental emergency calls occurring.

Eliminate unnecessary complexity – Each menu had the goal of containing less than five different directions to go. On pages where food options are listed that number was

exceeded to limit the level of layers in depth the user would have to search to find a feature. Simple iconography was used to limit the word count and speed up the navigations.

Maximize legibility of essential information – Use of sans-serif typefaces, large fonts and high contrast between text and background is intended to improve legibility. When text is not readable, icons are used to offer an alternative indicator of where to navigate. The settings page would also allow for the fonts to get larger to be more accessible.

Differentiate elements in ways that can be described – Large contrasts between unique common colors were used. Icons, colors, and text were all used to provide indicators for the differentiation of buttons and information.

> *"systems approaches are necessary to understand the multiple, complex interactions between humans and systems as well as between systems." (Carayon, 2013, pp. 12)*

From readings on the subject, many questions and goals were collected to help guide the development of the ConnectED app. Gosbee & Gosbee (2007) recommend asking "does the software provide functionality needed by the user?" and "is it obvious what the user must do next?" Especially in cases like the ConnectED app where every patient user is a new user, easy and obvious navigation is essential.

Figure 3.8 Mind mapping final wall layout. Hansen 2018.

Patient Story: There was so much going on, and despite nurses checking on me regularly, I still felt like I did not know what was going on. Not just with me but with everything around me. The door was open, so I could hear all sorts of things were happening, but all unfamiliar to me. I just kept thinking all I want to know is what is going to happen to me. -Anonymous patient

3.4 DIGITAL INTERFACE

Paper interfaces can only solve a few problems; you cannot get a realistic interaction with a user from a paper prototype. After creating 80+ still digital screens, imported these files into an online digital prototyping program called InVisionApp [https://www.invisionapp.com/] to test user's reactions to the ConnectED app and to find errors and flaws in the logic. When viewing the prototype on a computer screen, it simulated the look of the interaction of a tablet (see figure 3.9).

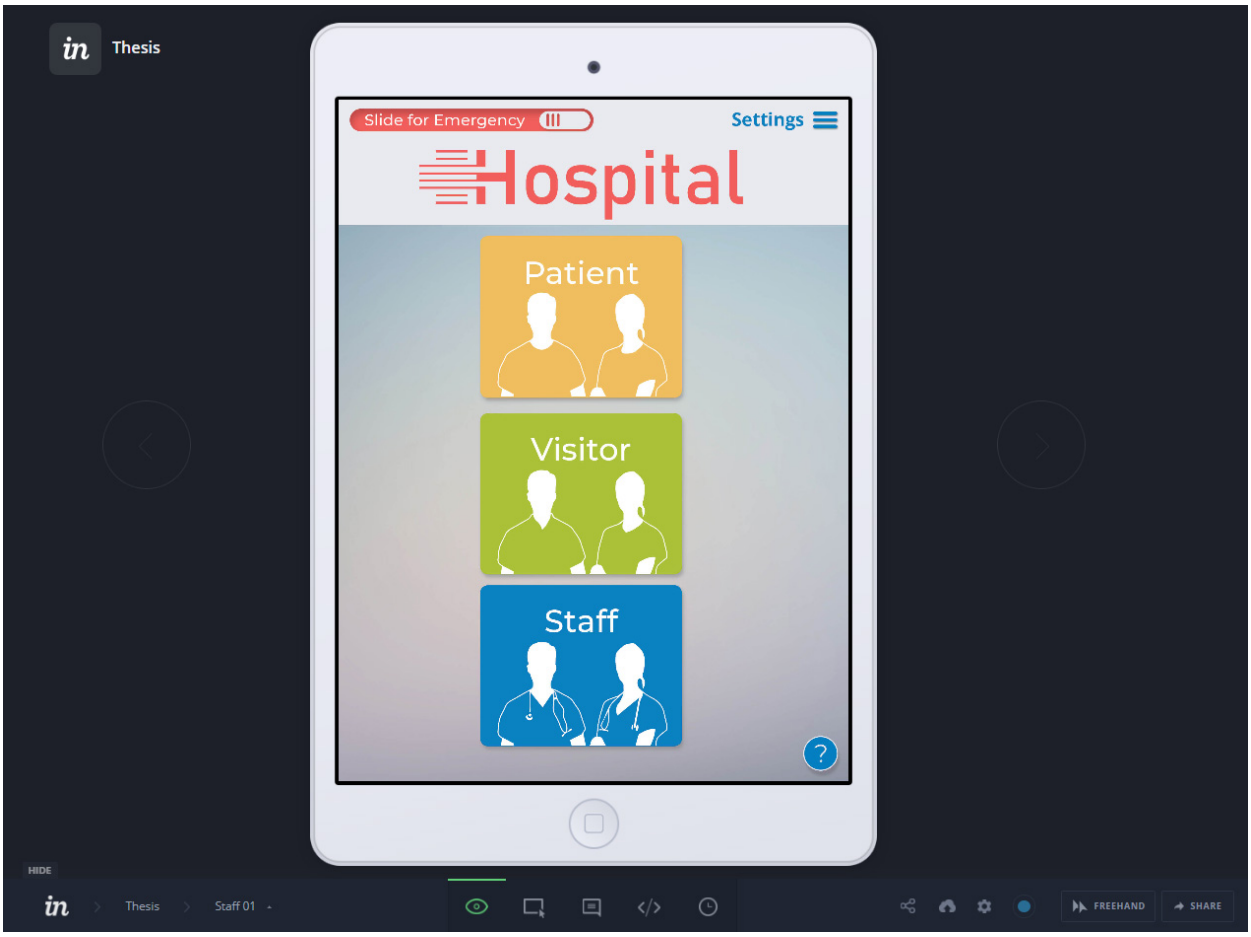


Figure 3.9 InVision interactive online prototype. Hansen 2018.

"ICU Workflow should include… the safe use of visualization interfaces that are designed and usability tested." (Faiola, 2015, pp.60)

Problem: The app had only been tested in a non-digital medium and paper prototyping, so a more authentic experience was needed. Although full testing of the app would need to be applied in a hospital setting, problems of the user interface and potential confusion with the app can be tested with random people as users to simulate as authentic experience as possible. Hidden bugs, functional mistakes, or missing content can be addressed outside a hospital setting.

Method: A link to the online InVisionApp website was sent out to approximately 40 people. The recipients were given limited information about the system and only told *"I am developing an interface to help patients/visitors have a better experience in hospitals, specifically, the emergency department. If you have a few minutes could you look at the interface and give me feedback?"* This gave the participant a similar experience to what the patients would feel in this situation without any experience or background knowledge of the app.

Result: The results of the study were significant. 32 of the 40 users responded with comments and suggestions on improving and fixing the app. Results ranged from testers identifying a simple spelling mistake to recommendations on how sections of the app could flow more seamlessly. This section of the testing process was the most informative and resulted in significant changes during the process of the design development. Getting the users involved with the app gave a new perspective on how the app would be used. A potential area for future development would be the training/learning of patients to use the app instead of being blindly asked to use it.

Prototype as if you are right. Listen as if you are wrong.

– Diego Rodriguez (Rodriquez, 2009)

This project was meant to provide a service to everyone in the hospital. This project could not have been completed without the contributions and feedback of many people, especially during the development of the digital interface. The overall responses tended to be more positive with proactive suggestions of new services or improvements. With the email advice and online comments came more stories of people's experiences in EDs around the world. This was a confirmation of just how many ways this app could be used, and as some put it provides 'a much-needed improvement.' This final feedback and information helped refine and direct the design efforts towards a digital product and helped identify specific actions that would serve as goals for the final push of this project. Their stories, comments, and feedback provided inspiration to finish this thesis.

Focus on user experiences—creating not just a service but a whole experience that appeals and works on a cognitive and emotional level. (Bate, 2006, pp. 309)

CHAPTER 4: CONCEPT

To finalize the direction of this project specifics of the goals and uses was determined by the inputs of all the previous research and testing. To define the final goal the AEIOU mnemonic (McLoone, 2015 pp. 28) was used to narrow down what the minimally viable product (MVP) would be for the product.

Activities: The app supports critical tasks such as providing access to blankets, water, food, and help to sleep. The app should also serve to inform that patient about a variety of areas, patient health and treatment plan, hospital information and locations, and documentation information. The final goal is to offer entertainment and distractions to the ED environment.

Environment: The product will be used in the rooms of Emergency Departments and will be used throughout the stay of the patient. Other alternatives, such as a lobby version, could be possible but are not the focus of this project.

Interactions: The device will be interacted with via a touch screen (i.e., tablet) device that would be installed in the room. The device should also have voice command ability to promote more inclusivity for patients and allow staff to interact with the device from a distance.

Objects: The main device designed is the interactive tablet for patients. The secondary devices would be the computers, cell-phones, and devices that the rest of the staff interact with to connect with the patients. The app itself is the final object that connects everyone in one central location.

Users: The target user is ED patients and staff. The market is every age, race, gender, income, size, ethnicity, intelligence, physical and emotional capability. Everyone.

Figure 4.1 Product introduction storyboard. Hansen 2018.

There are several use scenarios for how this product would get introduced to the patient. The one envisioned for the project involves a nurse initially using the device with the patient for triage and then data entry for the patient. After the documentation process is completed the nurse hands the device over to the patient to use

independently. The hand-off process would involve a brief set of instructions on what the device is and how to use it. The first pages the patient would see are information and instruction pages about the app to reduce the time the staff needs to be involved in the patient learning process.

4.1 WHY IS THIS NEEDED?

ConnectED is a communication service that filters questions or requests to the correct resources, to save the hospital staff time and improve the patient experience. Through the project's research, it was determined that patients have many unfulfilled needs during their stays in an ED. Patients are hungry, feel uninformed, scared, and anxious during the experience. The requests to have those needs met are going to doctors and nurses, whose time is more valuable than to spend fulfilling simple needs that are unrelated to a patient's medical care.

Additional research showed that centralized information systems like EMR (Electronic Medical Records) had been found to be inaccurate (Kaboli, 2004). For example, at Carle doctors collect information in the patient room and then fill it in later at a computer. "EMR Systems are perceived as an obstacle to delivering patient care" (Green, 2015, pp.5). Having these devices in the patient treatment room could promote more face-to-face interaction, something that is fading in healthcare. All this and more shows the need for having a centralized communication system to be installed in the patient rooms.

"We are, you are, the most underused resource in health care"

- Dave deBronkart (deBronkart, 2011)

Medical records that are incomplete, including checking and updating the allergy and medication lists are things that patients could complete on their own without the healthcare practitioner present. That information would then be reviewed with the patient and validated by the staff, instead of spending the time to collect it. Hospitals need to be able to track and document to improve (Haas, 2015). This project is meant to serve as the starting place for these services to start. Not just an app that gets you a cup of water when you are thirsty, but an app that promotes a new system of healthcare information.

4.2 INTERFACE

The app was developed in three components, security/login, home screen/menu, and the menu branches. This app is built upon systems that are already in place, like electronic medical records and ED displays in patient rooms and hallways. "Status boards are important tools for providing safe care in the ED (Wears, 2002, pp. 714)." The status boards in the room are a way for patients and staff to share information but are limited to what can be physically done in the room. The ConnectED app is

designed around that status board having a digital transformation adding up-to-date information and a large amount of additional information.

Information is accessed through a pattern called ‘nested doll.’ The structure is based on linear navigation of moving forward and backward through pages which is accessible and convenient for users. “Mobile experiences that employ the nested doll pattern are all about funneling users to detailed content…It’s a pattern that has a strong sense of forward/back movement” (Hinman, 2012). Starting at the patient home page the user moves into a section, deeper and deeper and then can either jump back home or go back step-by-step.

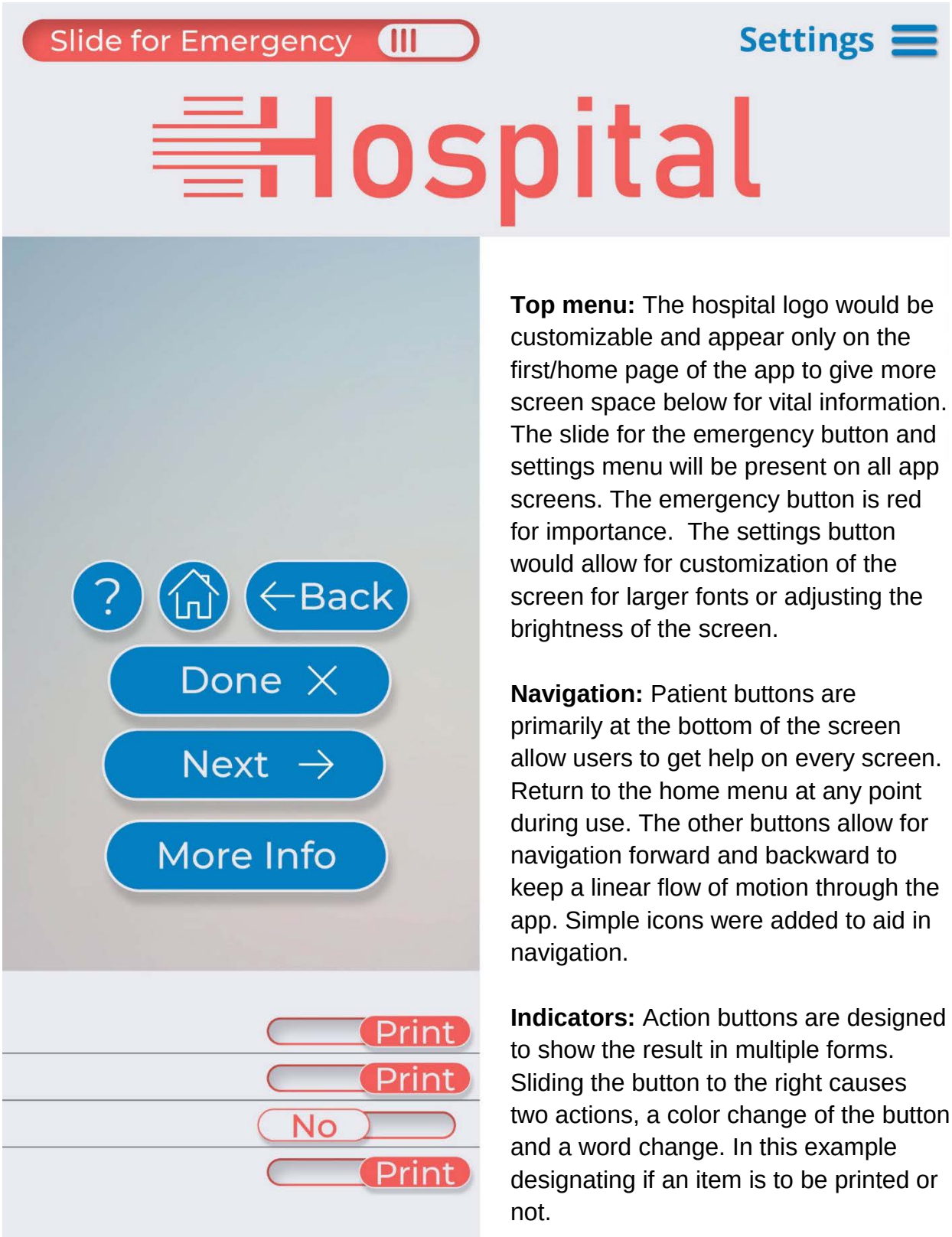
With the structure, use-case, and goals all set the application only needed to be stylized and developed to meet the requirements stated earlier. The features of the app will only be usable if the app is accessible to a variety of ethnicities, ages, abilities, and educational levels of patients.

4.3 COLOR AND STYLIZATION

The colors help guide the user through differentiation, but they also help set a mood that can impact the emotions of the user. The bright colors were meant to contrast the starkness of the traditional emergency rooms that are beige and monotonous. Hospitals like the Abilitylab in Chicago are examples of how entire hospitals are making the switch to bright colors.

The typeface chosen was Montserrat for title text and Open Sans for body text. The two typefaces pair well together and are legible, reader-friendly, and clean. Montserrat is considered a pleasurable font lightening up the mood of a digital interface, and open sans is a typeface that is legible. The combination lightens the mood of the information and is clean. Both typefaces are free to use from Google Fonts (https://fonts.google.com/).

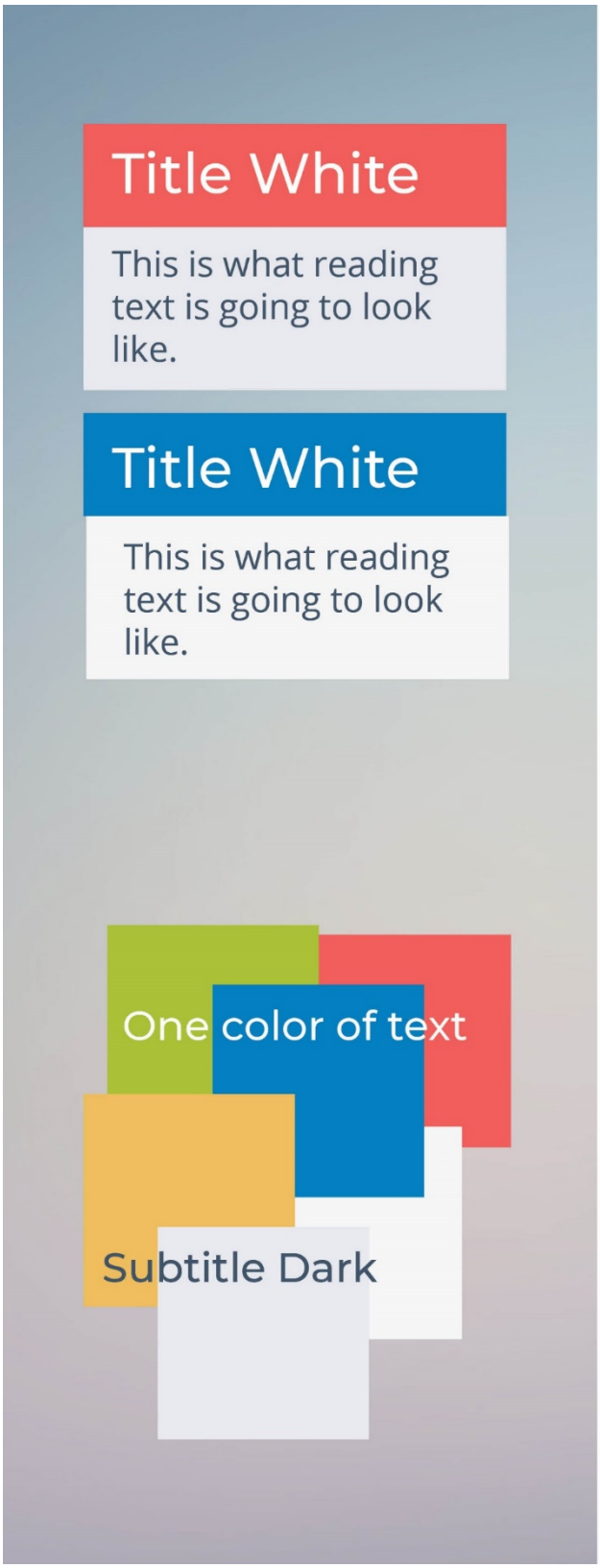
On the follow pages (pp. 38 thru 66) are images showing how the application was designed. Sections of the application were inserted to explain specific visual and interactive conclusions. Specific functions are discussed and shown in use case scenarios to explain how the application would be used. These pages contain screenshots from the working prototype combed with type and additional visuals to walk the reader through how the ConnectED app functions.



Top menu: The hospital logo would be customizable and appear only on the first/home page of the app to give more screen space below for vital information. The slide for the emergency button and settings menu will be present on all app screens. The emergency button is red for importance. The settings button would allow for customization of the screen for larger fonts or adjusting the brightness of the screen.

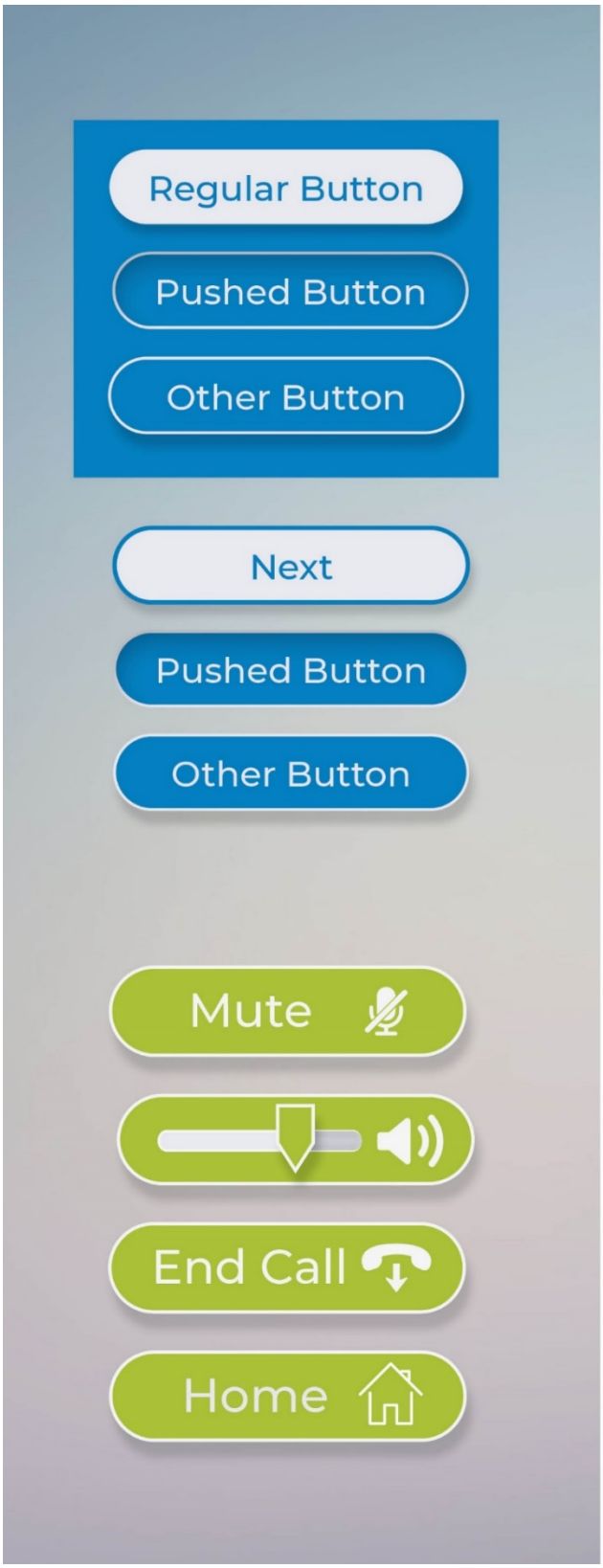
Navigation: Patient buttons are primarily at the bottom of the screen allow users to get help on every screen. Return to the home menu at any point during use. The other buttons allow for navigation forward and backward to keep a linear flow of motion through the app. Simple icons were added to aid in navigation.

Indicators: Action buttons are designed to show the result in multiple forms. Sliding the button to the right causes two actions, a color change of the button and a word change. In this example designating if an item is to be printed or not.



Menus and messages: Large titles and colors indicating the importance of messages help the viewer quickly and easily determine the importance of an item. Red title messages are more critical; blue messages are less critical. The typefaces are all large and easy to read.

Colors and type: Readability is important for this app, especially critical messages. Having a range of colors to differentiate information will aid the user during their navigation of the app. Each color will be associated with a specific section and set of information. The colors were tested for readability with both dark or light text on them.



Buttons: A small percentage of ED patients would not have experience with digital interfaces. The buttons were designed to have a 3-dimensional look using drop shadows so that they look raised or depressed. This visual indicator would imply to patients which things on the screens are buttons, and which are not. Rounded corners, as well as drop shadows, are used to separate out messages and text boxes from buttons. Each section of the app has its own color pattern and the button colors change to match the section.

Icons: Whenever possible, buttons have icons included to designate what their purpose is. Common icons that are recognizable by most Americans were used to give an additional visual indicator of what the button does as opposed to the text.

4.4 PAGE LAYOUTS AND FLOW

The following pages[2] are each show a section of the app as a patient would experience it. Arrows indicate the direction of the flow when buttons are selected, including timeline images and physical interactions that occur between patient and staff from the point the patient enters the hospital through their release.

The second section shows individual app pages and explanations of the functions and specific inputs that led to their designs. The final page is a summary of the three different logins: patient, visitor, and staff, and explains how each of those leads to different information and a different structure.

[2] All images on pages 42 through 66 are referenced to the creator Michael Hansen, 2018.

Visitors require no login and get direct access to public information and amenities in the hospital.

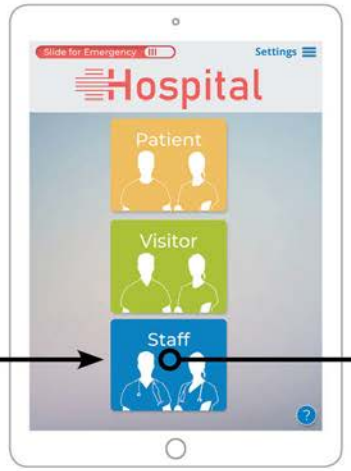
Patient's would be required to log in to the system with the information that the hospital has collected about them to keep their information secure. Information such as birthdays, social security numbers, and maiden names would be entered in the triage process and used to keep the data secure.

Staff can enter a password manually or use facial recognition technology to quickly login to the system. This cuts down on login time and the need to memorize long passwords.

Visitor button has no access to patient information but access to hospital information and can be used by anyone.

Patient button takes you to the home screen where the patients health information is. The main buttons for navigation along the bottom.

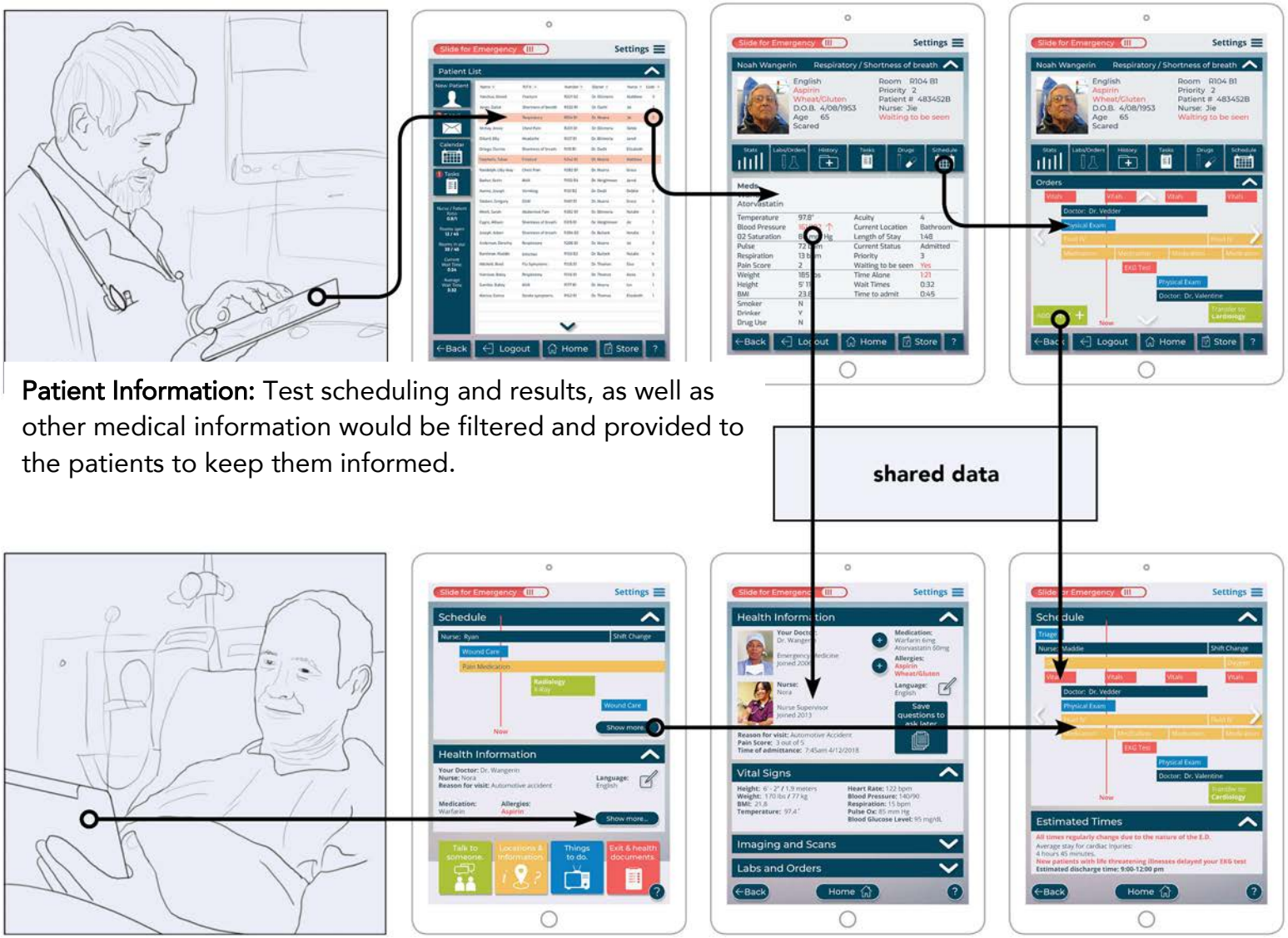
Staff button takes them to the patient portal page. A customizable menu and hospital information section to keep them in control and informed of what is going on in the hospital.



Scenario: A new patient comes into the emergency room and needs to be entered into the system. The nurse will sit down with the patient and go through a flow of pages to collect all the vital information, including demographics, insurance, reason for visit, history, vitals,

Hand-off: Once the triage process is complete, the patient would be offered the device and given a few short directions on what the device is and how to use it. The system would be designed so that this hand-off would be as simple as possible.

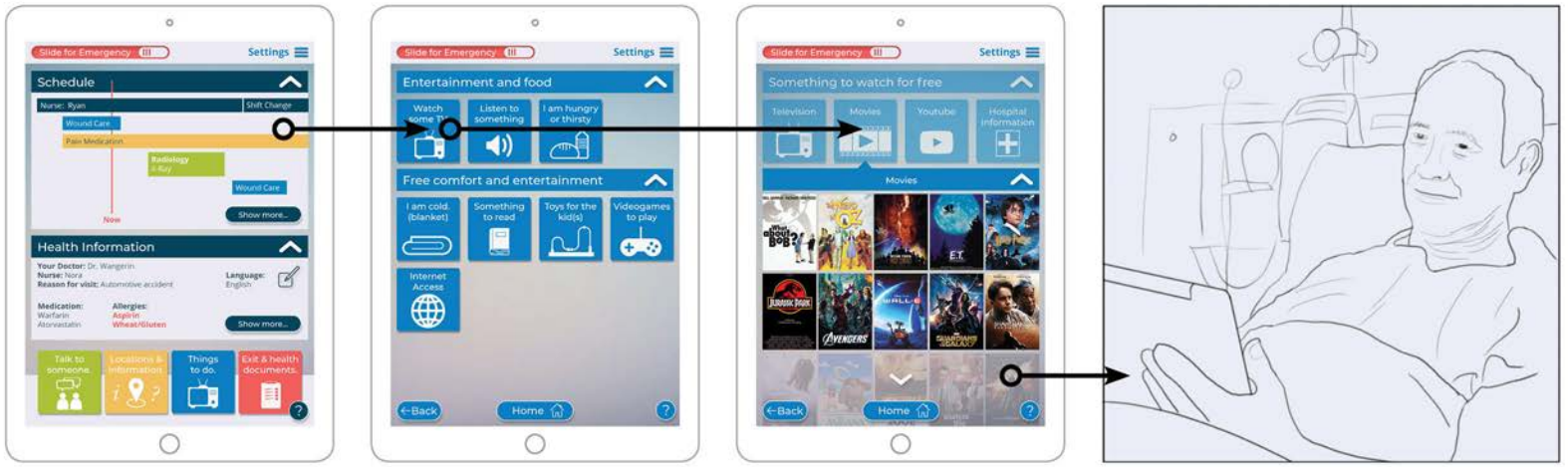
Data Sharing: The app allows the patient and staff to share information in a close to real-time experience. As doctors and nurses schedule tests and get results, that information can be shared either via the ConnectED app or in person.



Patient Information: Test scheduling and results, as well as other medical information would be filtered and provided to the patients to keep them informed.

Scenario: The patient is thirsty but doesn't want to bother the doctor or nurses with asking for water. With just a few taps a volunteer will deliver it.

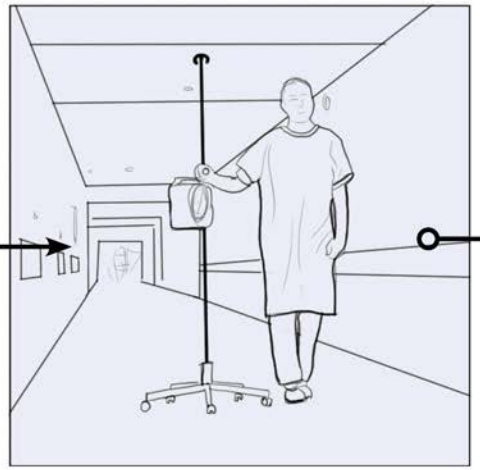
Scenario: A patient is going to have to wait a few hours to have tests run and then wait for the results. Now he can wait with a library of movies to keep entertained.

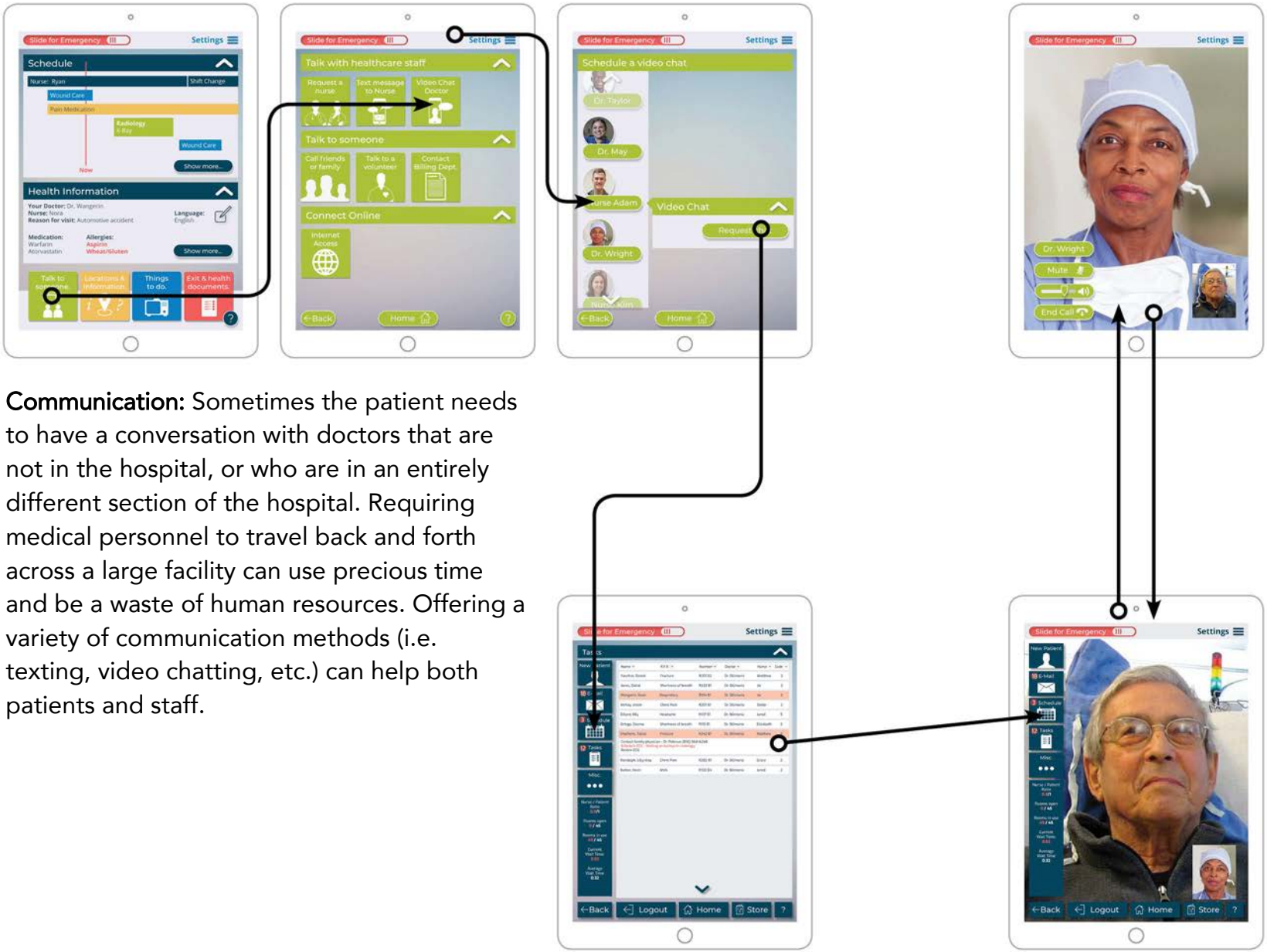


Restroom: If a patient needs to use the restroom, he can call for assistance if needed, or simply mark that he is in the restroom, so the staff know.

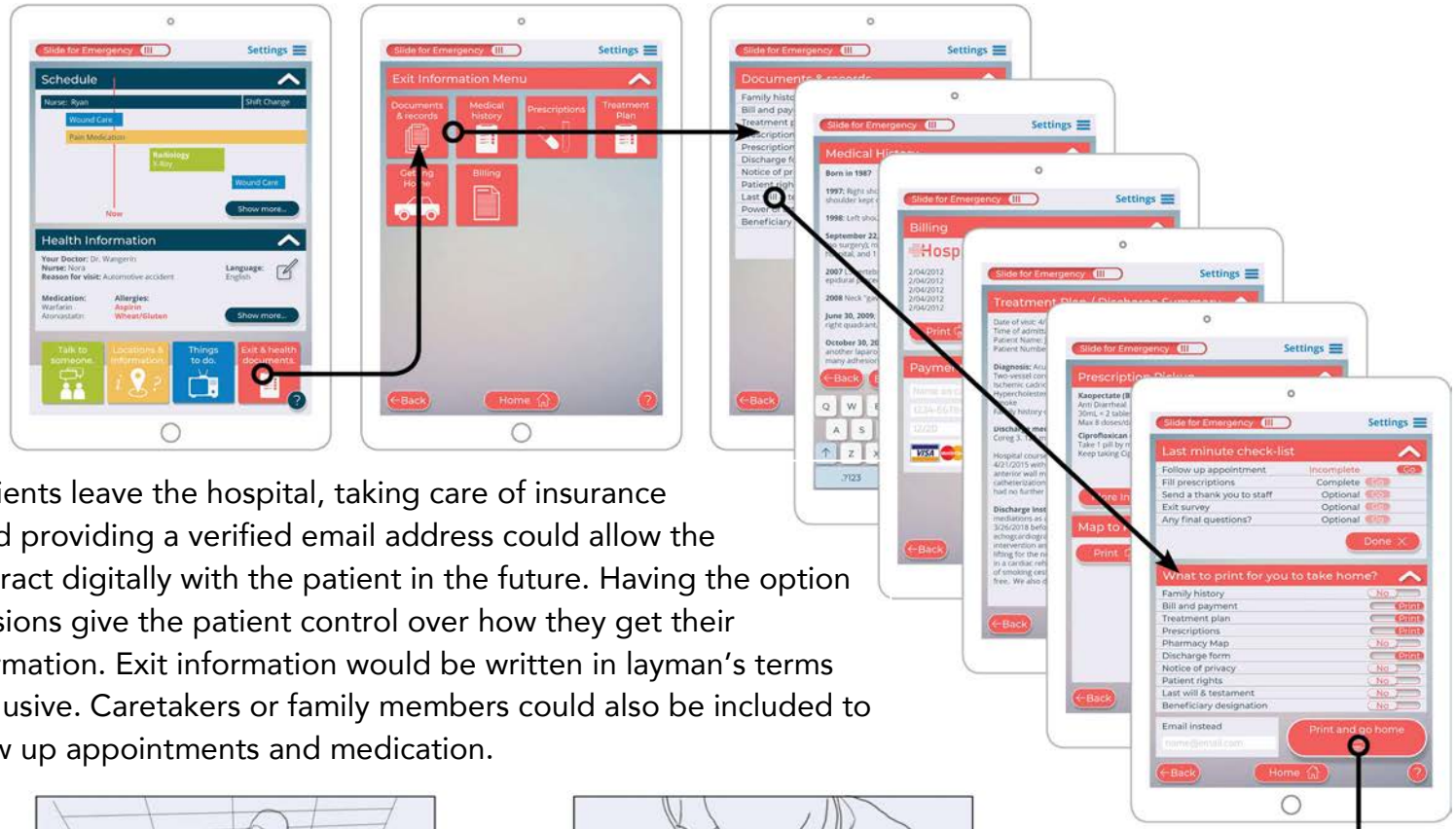
Staff: Staff can pull up a patient's information page and see their current location, i.e. 'Restroom' so they know to see the next patient instead.

Return: Upon returning to his room, the patient uses a single button to change their location to 'in room' to inform the staff.

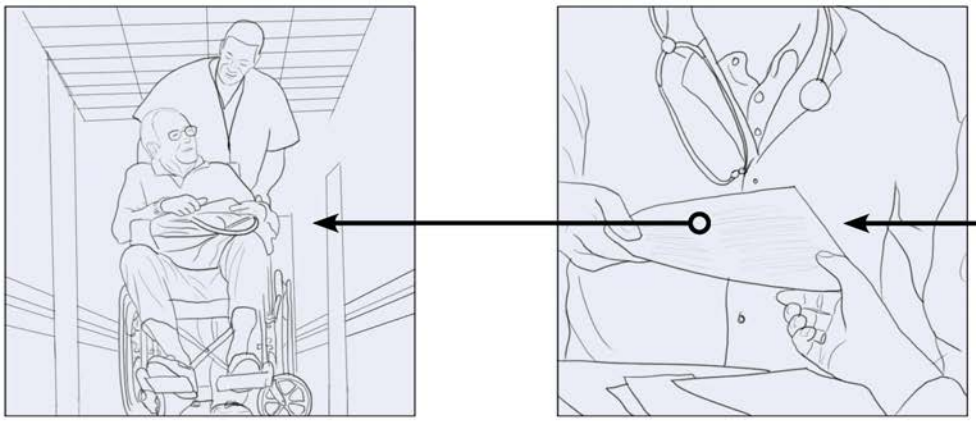




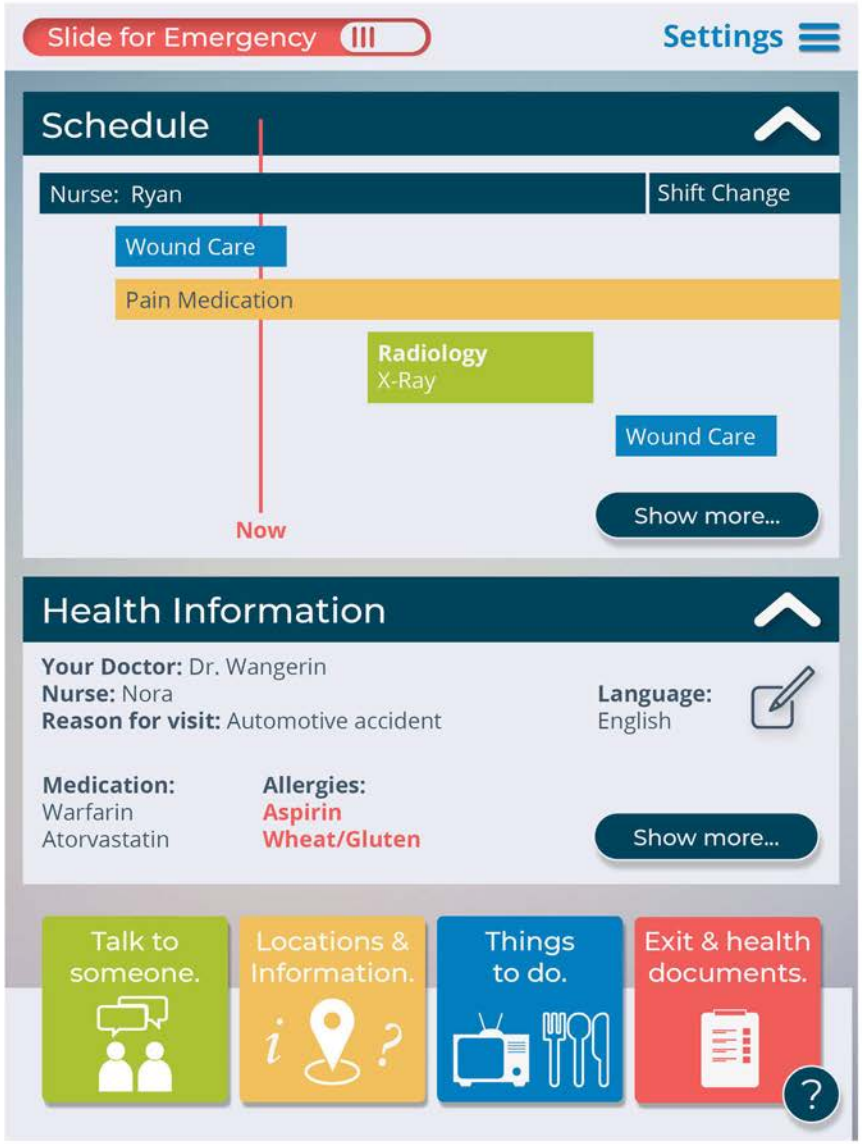
Communication: Sometimes the patient needs to have a conversation with doctors that are not in the hospital, or who are in an entirely different section of the hospital. Requiring medical personnel to travel back and forth across a large facility can use precious time and be a waste of human resources. Offering a variety of communication methods (i.e. texting, video chatting, etc.) can help both patients and staff.



Exit: When patients leave the hospital, taking care of insurance information and providing a verified email address could allow the hospital to interact digitally with the patient in the future. Having the option for printed versions give the patient control over how they get their treatment information. Exit information would be written in layman's terms to be more inclusive. Caretakers or family members could also be included to help with follow up appointments and medication.

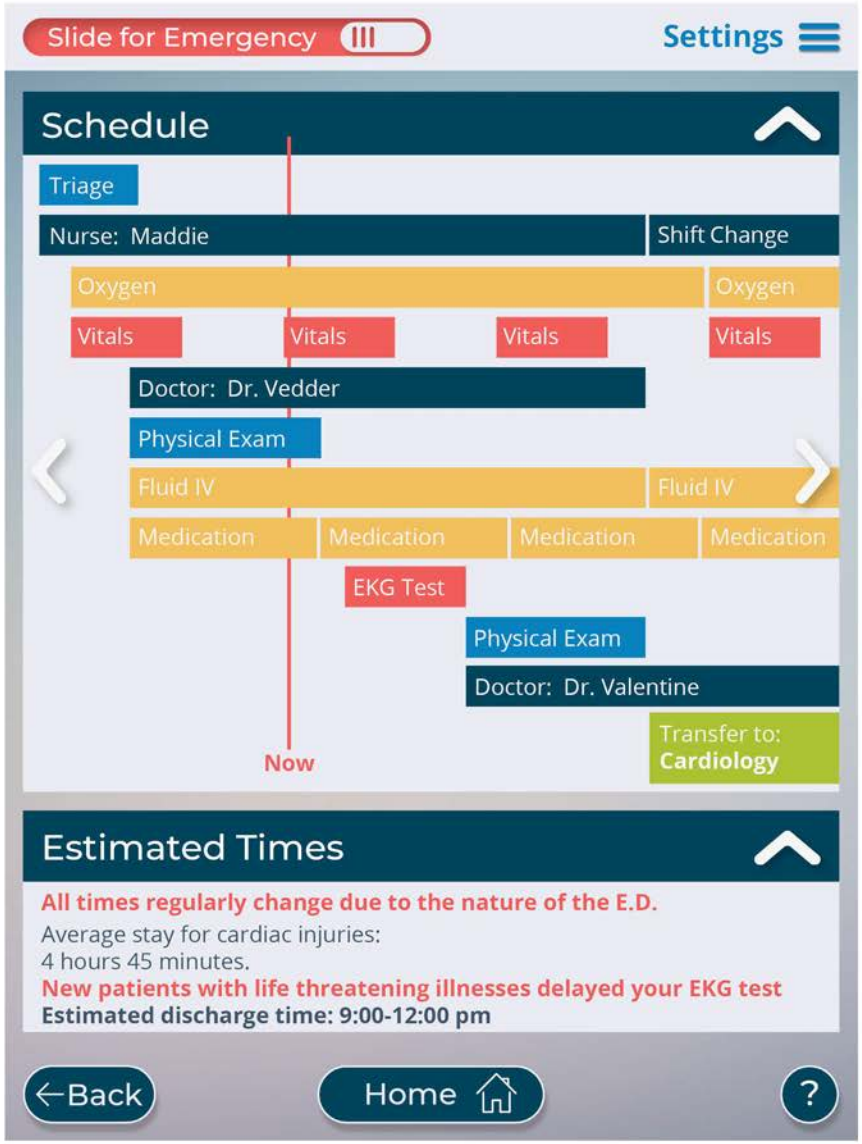


Welcome Screen: There are a few items that a lot of the staff wishes that every patient knew when they entered the hospital. The screen that a patient sees after selecting the patient button is the screen on the left. This could be customized and updated to match the needs of each individual hospital.



Patients home screen: One of the most common phrases repeated by patients during the project was "I just wish I knew what was going on." The home page shows a schedule of what is going on happen coming up, the basic health information of the visit, and a menu for other sections of the app.

Both the schedule and health information can be expanded on for further information, and even the language can be changed. This section is the place that would be continuously returned in order to reach the rest of the applications features.



Patient Schedule: The schedule is designed to help the patient know more about what is happening with their treatment plan.

Because of the chaotic nature of the Emergency Department, times are not always listed for events. This still keeps the patients informed but possibly less anxious. Each event can be expanded if the patient isn't aware of what the even is. Clicking on "medication" would list the medications that the patient is taking and provide information about them.

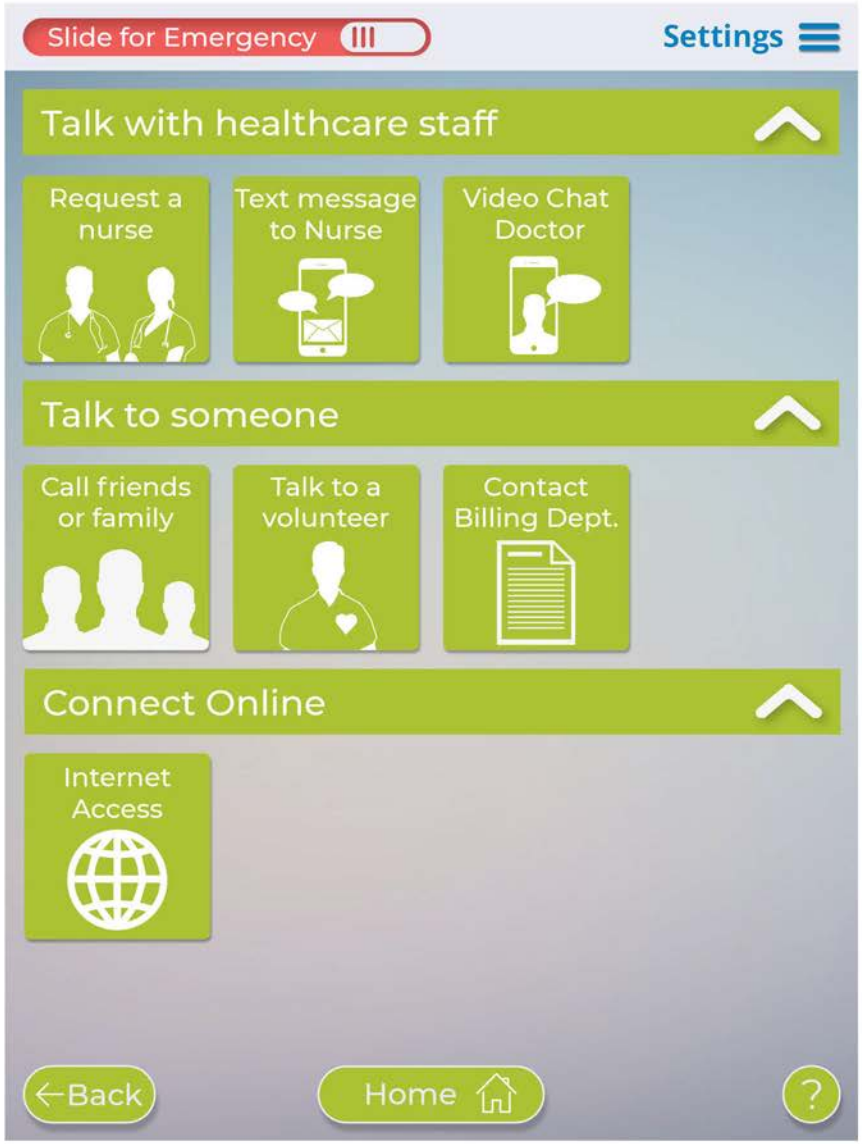
The estimated times at the bottom can give additional information about the hospital and how long they think the treatment will take for the patient based on previous data. When the hospital is busy, everything gets delayed and the patients usually are unaware of that kind of information.

Talk to someone: Communication is critical for patients. Having access to a variety of people can help meet essential needs. Examples are calling a family member to let them know you are ok, text your nurse a quick question, or video call your primary care physician in another city. This section is all about connecting the patient.

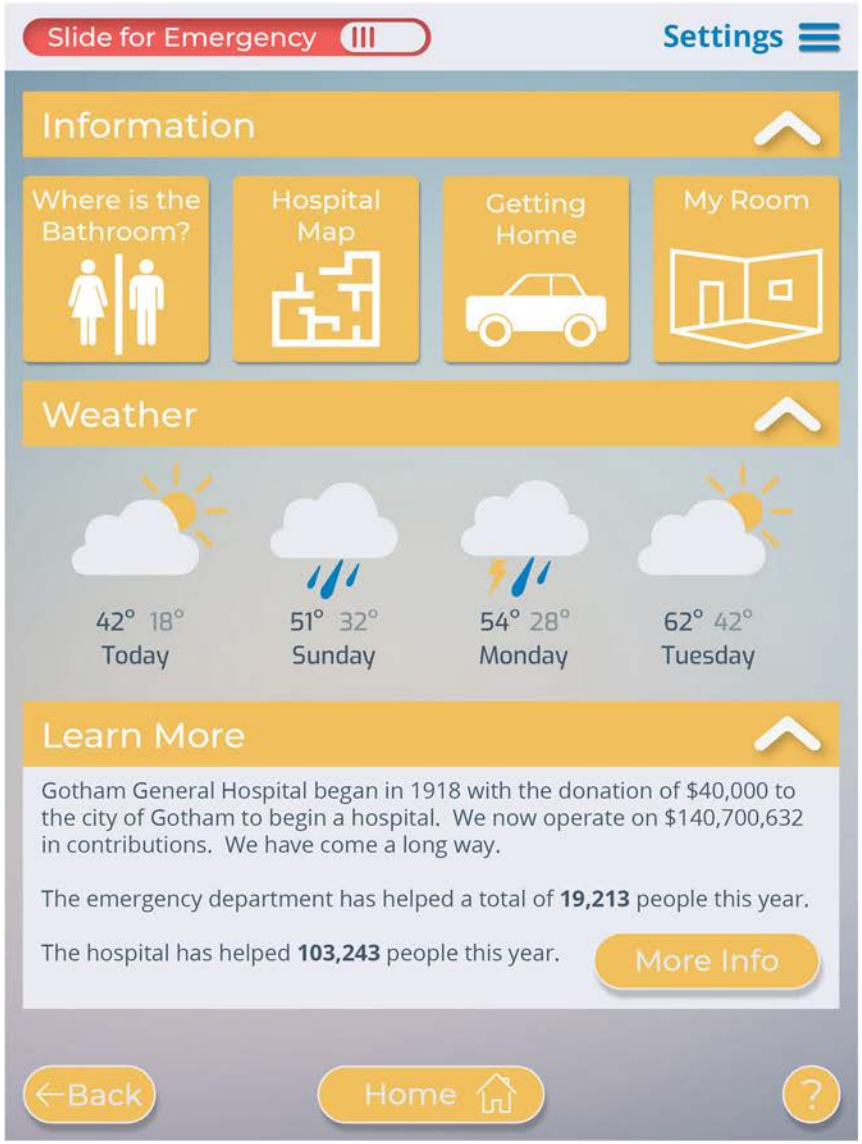
Locations & information: Knowing where things are located can be complicated, especially if you have never been in a hospital. This section provides information about the hospital and where departments and people are located. Even just finding the bathroom can be a challenge. This section provides information to the patient.

Things to do: Keeping a patient occupied is not the responsibility to the staff at the hospital, but nowadays is a society surrounded by technology, being idle is rare for us. Movies, radio, and more can be accessed. Basic needs like food and water can also be accessed from this section.

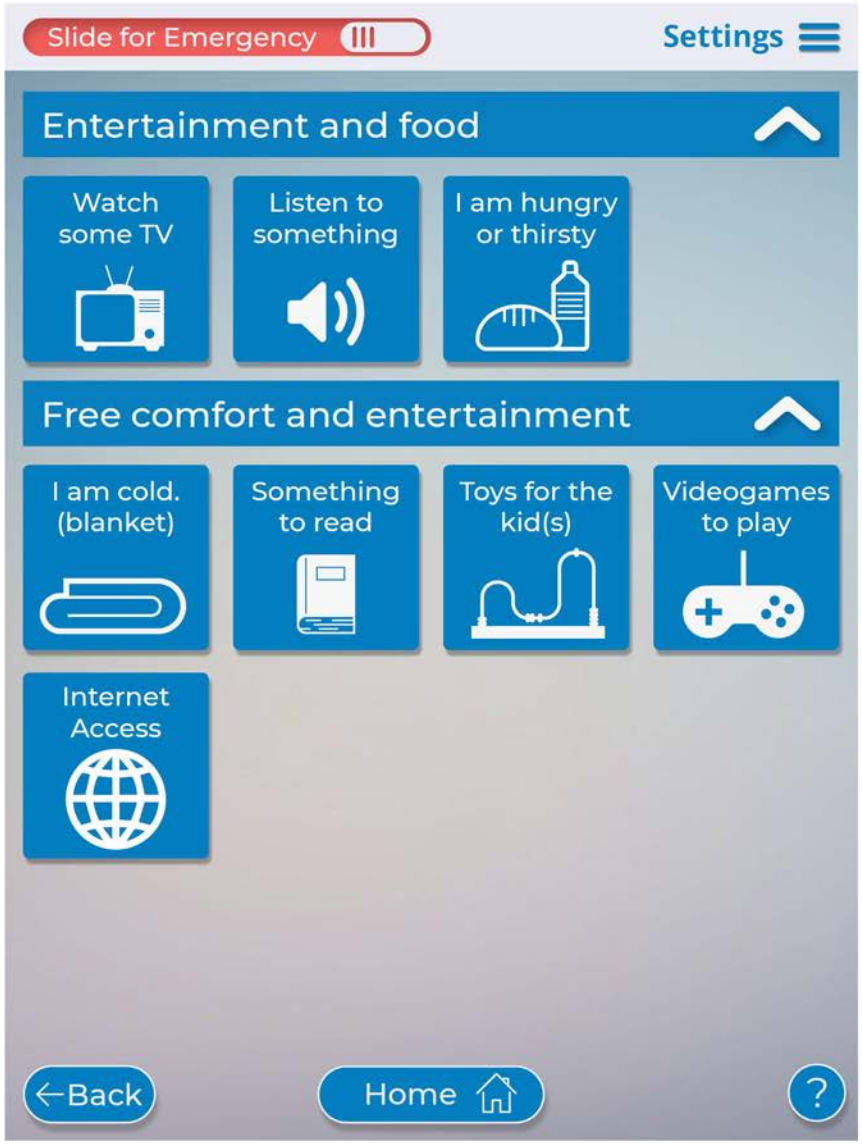
Exit & health documents.: When leaving the hospital, the exit process can require a lot of paperwork. Providing help with this can make a difficult process easier. Having the option to print or email everything to you can make things more accessible to everyone. This section is all about helping fill out paperwork and the exit process.



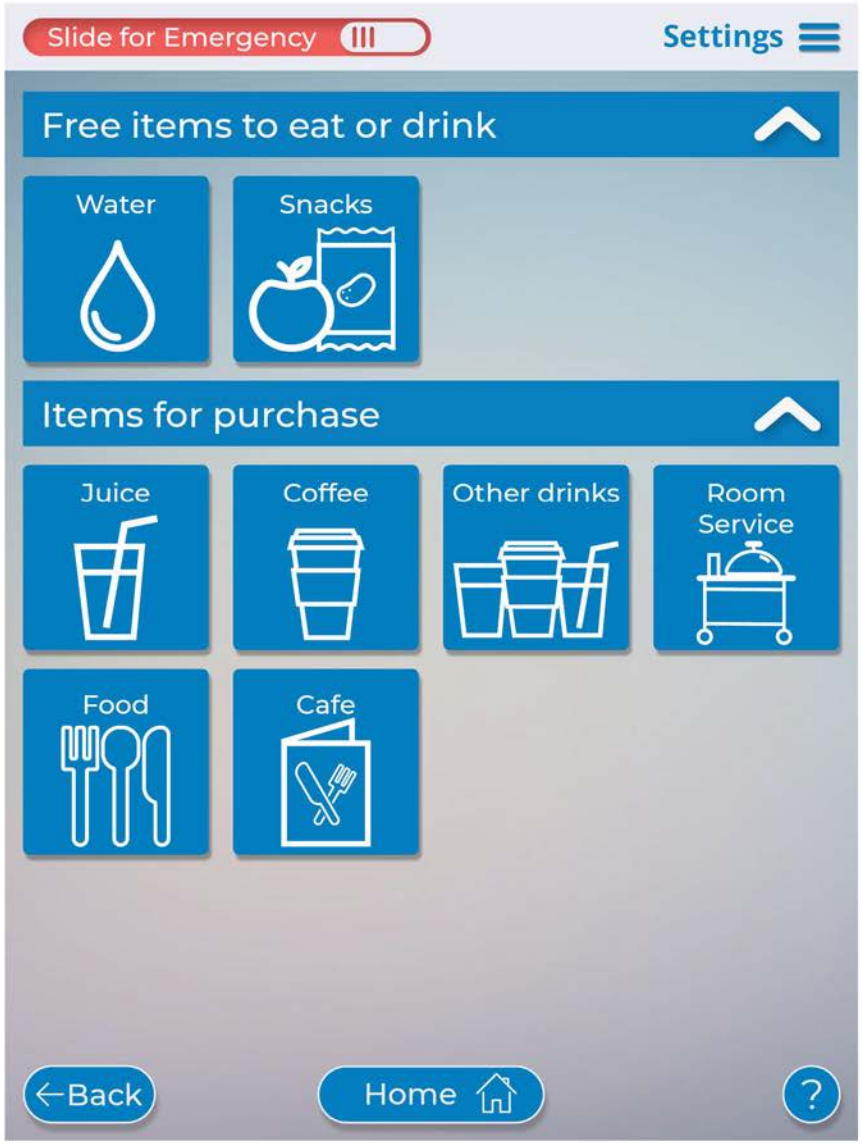
Talk to staff: Having a variety of ways of communication can be important for a patient and can improve their care experience dramatically. If a patient is embarrassed or too shy to ask a question in person, they can text the question to the nurses and doctors, potentially opening up communication and decreasing readmittance to the hospital.



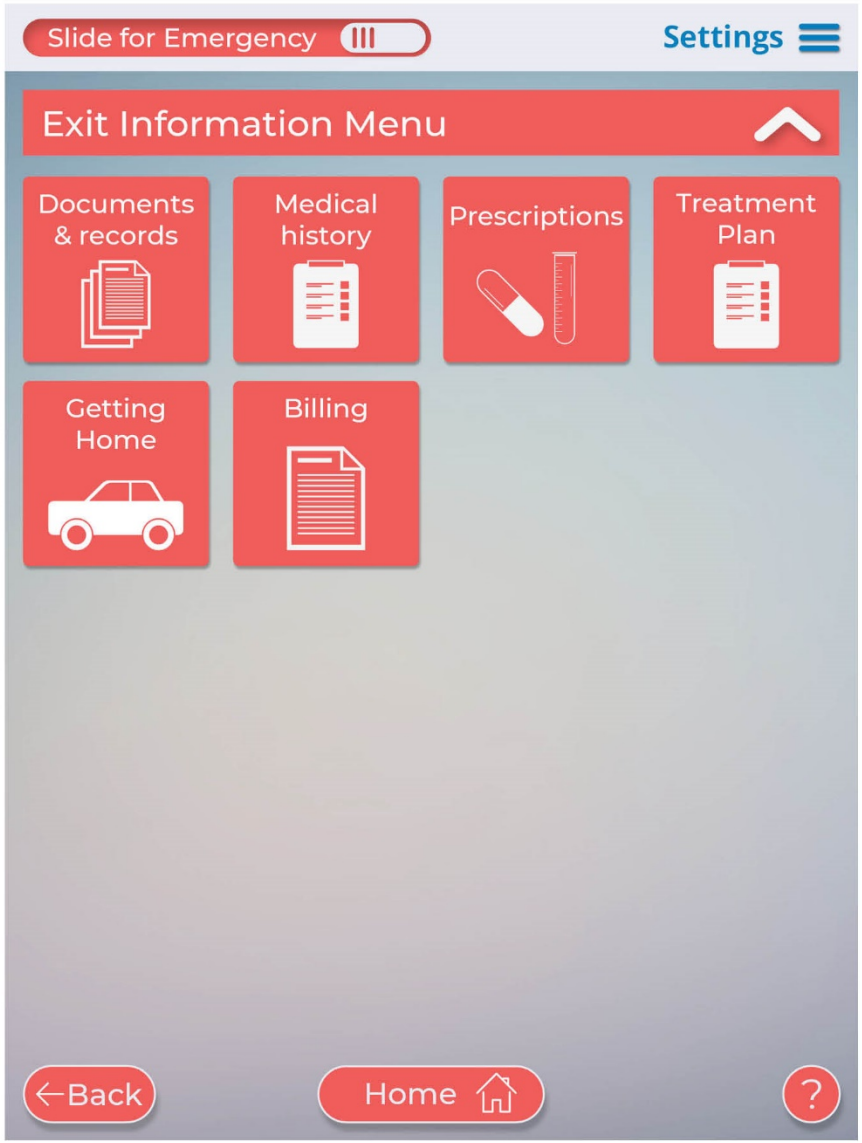
Information: Providing information to patients and visitors through the ConnectED app would save the staff time from having to point people in the right direction. These minor distractions add up to a lot of time. Information about options on how to get home could serve everyone.



Entertainment and food: Simple amenities could make a big difference for some patients like a blanket when they are cold or something to read or watch while they wait. Keeping a patient happy and distracted could make care easier. A parent with their kids shouldn't have to worry about their own health and their kid's boredom at the same time.

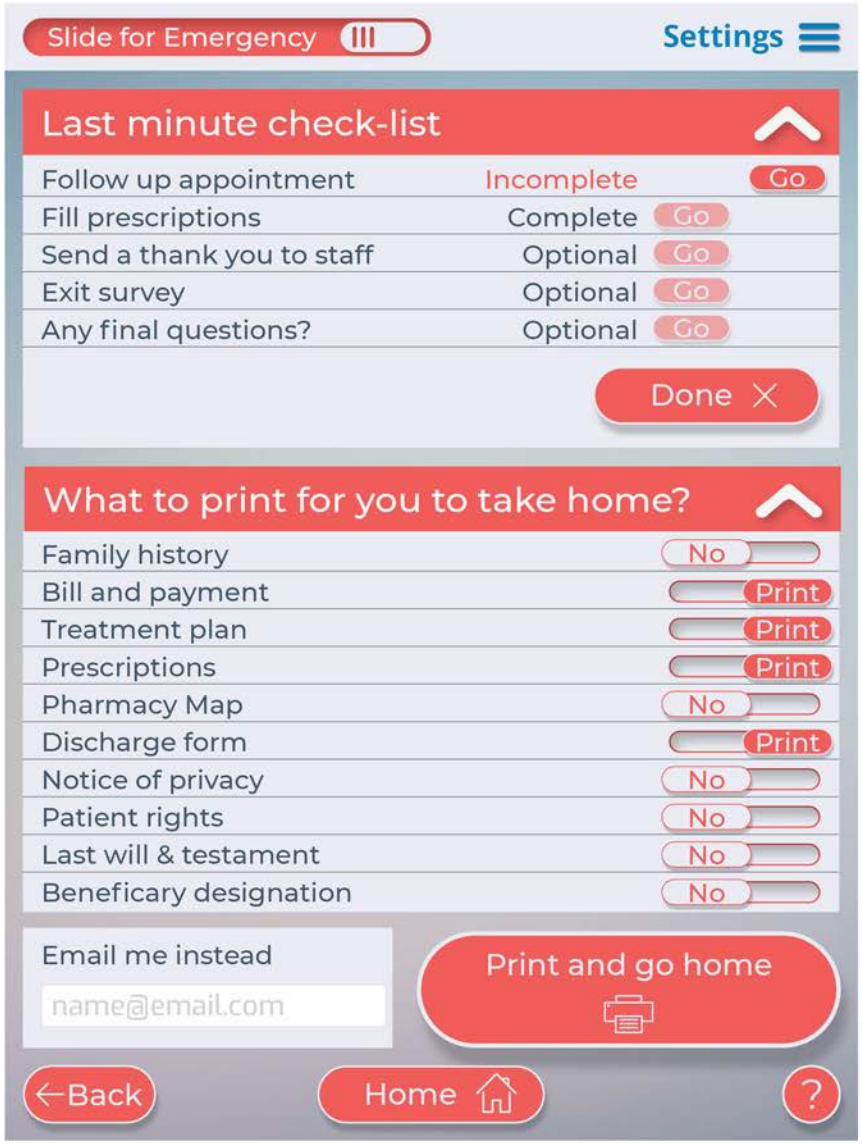


Food and drinks: Just getting a drink of water can be a complicated task in the ED. Having free options can help those that are in need. People with low blood sugar can get angrier quickly, and keeping people calm in the ED is important. Providing items for purchase by patients, visitors, and staff could be an added revenue service, something the administration would like.



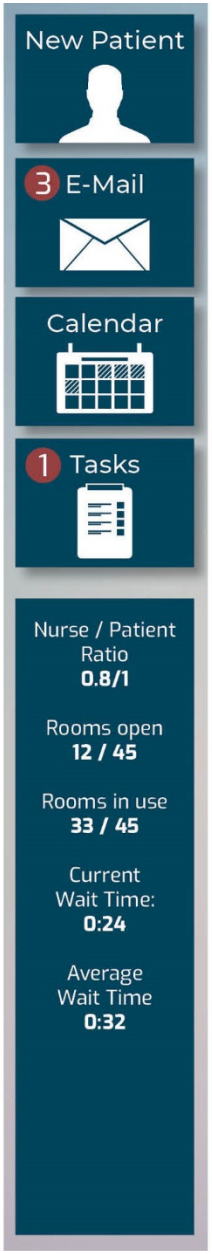
Exit: When leaving the hospital, paperwork is required, and that process can sometimes be incomplete. Providing a step-by-step guide through the exit process prevents staff from having to repeat tasks that the ConnectED app could complete.

Pharmacy: Rarely does someone want to stay in the ED longer than they have to. When they are discharged and ready to leave, making an extra stop at the pharmacy and waiting again is an unnecessary step. Options to ease that process would be part of the exit steps in the ConnectED app.



Exit Checklist: Having a clear step-by-step process to aid patients in their exit from the hospital could save the staff time. Enabling the patient to have a bigger role in the process could lead to less readmittance o the ED, which is a big problem currently. Patients are given instructions when leaving the hospital, but that information can be unclear or get lost if printed. If a patient is handed more information than they want, or information that is too complicated, they are less likely to read it, resulting in patients not following the correct treatment plan.

Staff home page: That patient list screen gives quick access to all patients in the ED and has the ability to filter from there. Only seeing the patients that a specific doctor are seeing. The highlighted red patients are ones that are requiring assistance or have recent test results available.



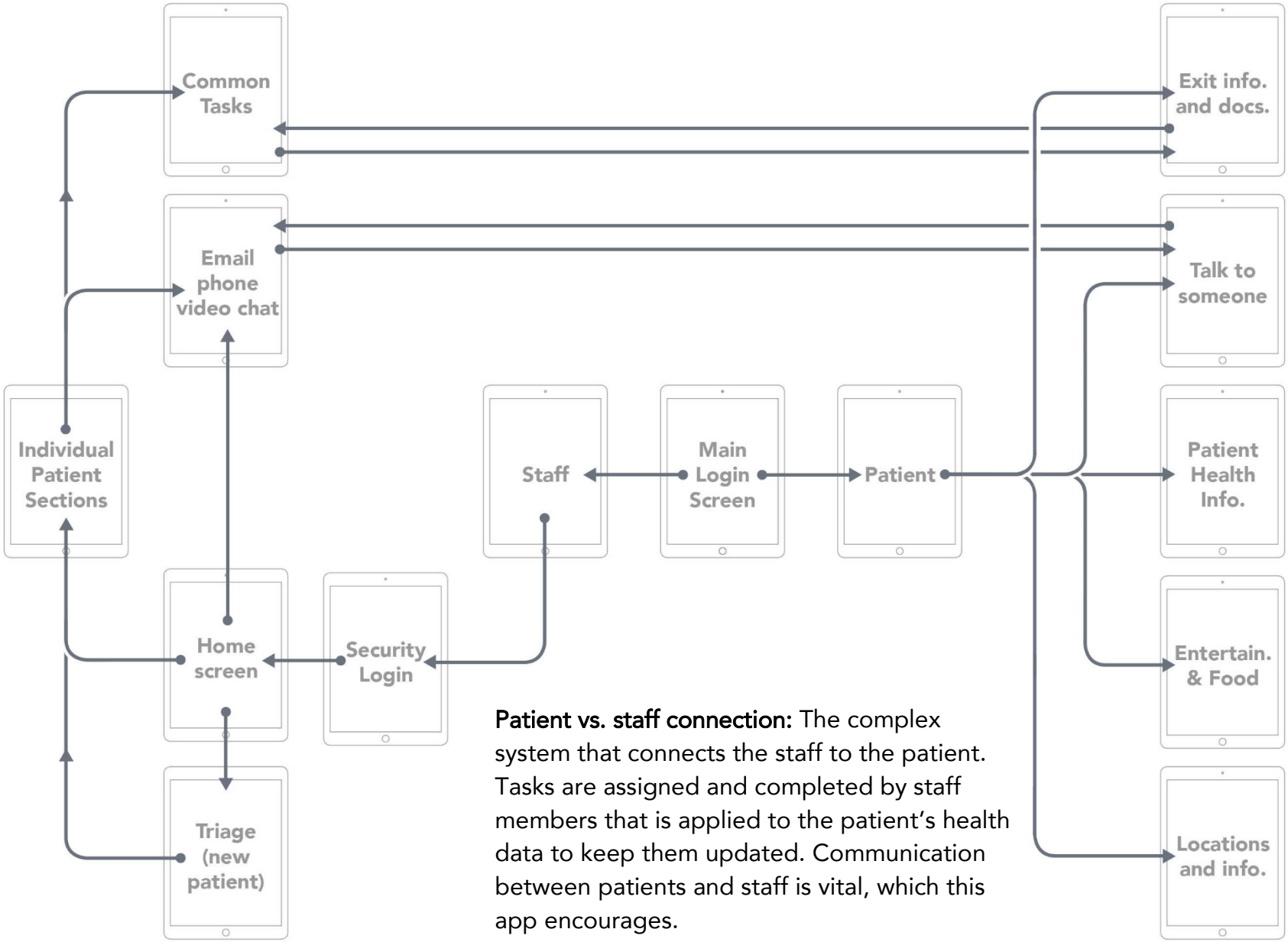
Staff side menu: The side menu would be a customizable area for staff. Additional buttons could be added or moved around to allow the repeated users the ability to make the system work best for them. The bottom statistics give the staff quick information on how the hospital is doing overall.

Staff bottom menu: Always having a logout button is critical for staff being able to quickly get out of the system. If an emergency situation occurs, they wouldn't want to have a long process to lock the system to help protect patient data.

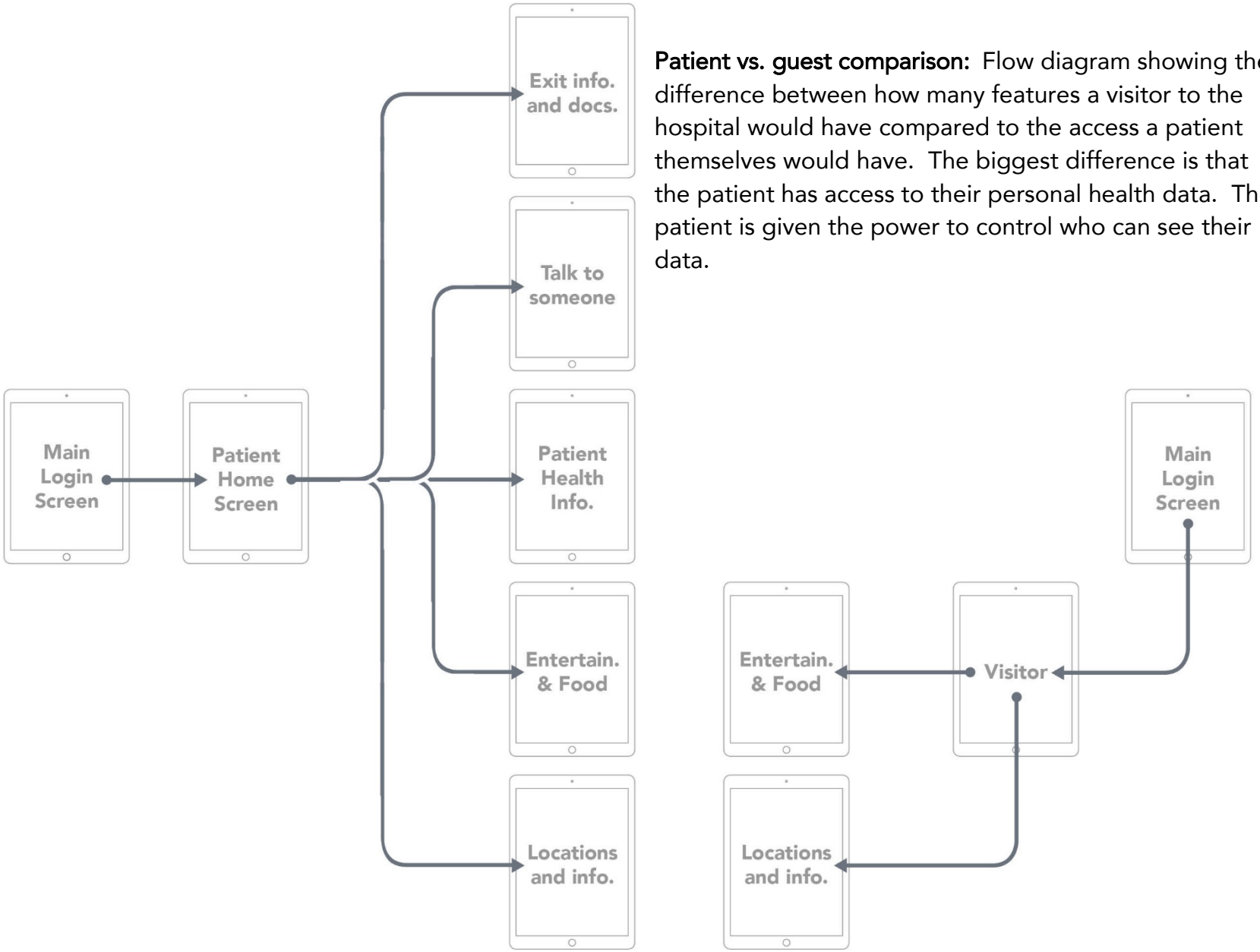
Staff patient pages: The homepage for each patient shows the critical information at the top and the other important information like stats and location at the bottom of the screen. Items like wait time would be added to increase the priorities of patient satisfaction.

Staff patient information: The most critical information that a doctor would need to see is at the top of the page with critical information in red. Patient check-in information would be displayed here, like the patient's emotional feeling of being 'scared'.

Staff patient page menu: This menu takes the staff quickly to every item they need. Large icons make finding specific items quicker and more routine for them, with the next being less important.



Patient vs. staff connection: The complex system that connects the staff to the patient. Tasks are assigned and completed by staff members that is applied to the patient's health data to keep them updated. Communication between patients and staff is vital, which this app encourages.



Patient vs. guest comparison: Flow diagram showing the difference between how many features a visitor to the hospital would have compared to the access a patient themselves would have. The biggest difference is that the patient has access to their personal health data. The patient is given the power to control who can see their data.

4.5 ADOPTION

This system has positives for all the stakeholders and goals set out earlier in the project. It gives value to each user to encourage their participation in this system. The original goals on the left with the result from that goal listed on the right.

Goal	Result
Improve the patient's experience	More information, basic needs services, entertainment
Increase empathy between people during care process	Communication, needs services
Improve the doctor experience	Control over communication, easier task scheduling, effective communication
Deliver inexpensive solution that provides income for the hospital	Patient data, sales revenue from food and product sales
Improve the patient's health	Better patient/doctor communication, more information, better exit plans
Provide benefits to the staff	Times saving, fewer distractions, needs services

Figure 4.2 Goal and result chart

The administration will get more health data and hospital information. Staff will have more control over their interactions with patients while being able to avoid unnecessary time-wasting tasks. Patients will have their needs met and be entertained during the process. Each stakeholder has a reason to want to make this system work. The potential negatives of this device are if a low adoption rate occurs and the system is not used, then the benefits might outweigh the costs.

> *"The difference between having a software solution for your problem and not having any solution is so great that we accept any hardship or difficulty that the solution might force on us."*
>
> *(Cooper, 2004, pp. 27)*

Although the system was designed to encourage face-to-face conversations some of those interactions will disappear. In the future development of this product, it will be important to keep that goal of encouraging face-to-face interactions. "When a hospital reflects on waiting experience, which is influenced by the design of the waiting area and information provision, each decision needs to be weighed against the social dynamics it generates" (Annemans, pp. 5, 2017). Research for this project showed that patients want more face-to-face interactions with the medical staff in hospitals but aren't getting it and may never get it. Doctors and nurses don't have the resources or staff to maintain the level of care they want to in the ED. This was a patient-centered project

that add new types of communication that aren't currently available and could make patient care more efficient. The application shouldn't be used replace face-to-face communication, but instead create new areas of communication that didn't exist before.

4.6 KRANNERT MFA SHOW

During the week of April 21st – April 28th all graduating Masters of Fine Arts students at University of Illinois Urbana Champaign put on an exhibit in the Krannert Art Museum. The show was titled "ConnectED Emergency Department: Putting the patient experience first." The goal was to show off the thesis project in an exhibit setting. Figure 4.3 displays the final installed exhibit plan.

Figure 4.3 Final installed display. Hansen 2018.

CHAPTER 5: CONCLUSION

In future generations of the ConnectED app, I would expect to further its abilities to serve patients. Improving the ease of adoption by hospitals, allowing for more collaboration with electronic medical records systems is required. Many of the decisions for the application design were based on current abilities and constraints in the medical design industry, but to be successful in the future, the structure of the app will need to be flexible to adapt to changes and developments in both digital and physical systems in the medical industry. This chapter reflects on what those systems could be.

Experts at making trend predictions, Herman and Devey, are predicting computerized devices, portable/mobile devices, and telemedicine as a few of the technology areas in their future trends list. (Herman & Devey, 2011, pp. 9). The technology and features used in the current app are trending towards being more used items in healthcare and will continue to trend that way in the future.

The hardware of the device would be a range of products. Options include a stand-alone tablet device or a system attached to the ceiling. Robotic systems could act as couriers or volunteers in the hospitals, never needing breaks or getting lost. Different departments of the hospital would have different needs fulfilled for the hardware. Many unconscious patients in the ICU would not need a permanent solution, so cart mounted systems would be developed to allow for flexibility in where the systems are used. The crowded hallways of the emergency room make navigating just about impossible for a robotic system, so permanent (non-mobile) solutions are more appropriate.

Figure 5.1 Potential future concept sketches. Hansen 2018.

Universal design is also important for medical devices because the accessibility and usability of this equipment can affect the quality of health care provided. (Story, 2007, pp. 84)

The ConnectED app should be a system that hospitals can control to customize it to their own needs. Like Apple has the App Store, the ConnectED app should have a modular system where items can be added/removed and customized by the hospital. Because the primary interaction is between the patient and nurse, the future research should revolve around that interaction while allowing the staff to customize the app for their specific job needs.

Artificial intelligence is already being used in chat communications for online customer service, and the ability to tell the difference between a human and a computer is getting more challenging. These types of low-cost systems are helping increase customer service and have potential to be used in the hospital setting to get patients help with simple requests. Computers are helping solve problems in our society, and the healthcare industry should be no exception.

"It is not the distinction between human and technologies that we need to depart from, but their radical separation."

(Verbeek, 2014, pp. 86)

There were many small goals for this project, but the main goal was simple; improve the patient experience. ConnectED creates an infrastructure for hospitals to improve communication and experiences of patients in the future. Getting the correct information to the right person is a huge challenge for hospitals. Providing immediate health information to the patient and the ability to communicate with the staff even when they are not close. These improvements would increase the capacity of healthcare practitioners to help more people by connecting patients and staff in a secure and easy to use application. On top of the health and emotional benefits of this product the patient's gain access to more amenities, information, and service than they have ever had in a hospital.

The ConnectED app gives patients the ability to communicate in ways they are more comfortable with, like texting. It gives them a resource to communicate with people outside of the ED, like family members, lawyers, primary care physicians, or a babysitter to help alleviate the stress of an ED visit. The app could guide you around the hospital to different departments, or help you find a ride home. Instead of having to walk across an entire hospital, specialists could check-in with patients via video chat saving considerable time, letting the specialist see more patients. The app can also get you snacks when you are hungry or water when you are thirsty to make an ED visit more comfortable. This app fulfills many of the needs that people have when they visit the

ED, needs that aren't currently a priority of the staff. The priority of the staff is on the health of the patient, and it should stay that way, this app helps free up the doctors and nurses from mundane tasks to spend more time helping patients with their health. The reason for the ConnectED app is to help both the patients and the staff use their resources more efficiently.

Patients that are unfortunate enough to have to visit an emergency department should not have to worry about anything but improving their health. It is impossible to prevent people from having to use the emergency department, but when they get here, the quality of the experience can improve greatly.

"I hope a system like this could make what might be the worst day of your life a little better." Michael Hansen, 2018

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